



## Ocean Exploration and Research

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# Expedition Cruise Report

## Cruise EX-15-04 Leg 2—2015 Hohonu Moana: Exploring the Deep Waters off Hawai'i (ROV/Mapping)

Remotely Operated Vehicle (ROV) and Mapping Exploration of the  
Papahānaumokuākea Marine National Monument

July 31 to August 23, 2015

Honolulu, Hawai'i to Honolulu, Hawai'i

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## Abstract

EX-15-04-L2 was a combined mapping and ROV cruise to the Papahānaumokuākea Marine National Monument (PMNM) that took place between July 31 and August 24, 2015. During the cruise, 18 ROV dives were conducted from 1,198 to 4,831 m between West Nihoa and Salmon Bank, for a total of over 98 hours of bottom time, and covered a linear survey distance of 6,211 km, including the deepest dive ever conducted inside the PMNM. The first ever sampling by ROV *Deep Discoverer* was conducted during this cruise, which yielded 31 rock samples and 65 biological specimens, 29 of which were commensal animals collected with the 36 primary specimens. Of those primary specimens, all were collected under the presumption that they might be either new species or new records for the region. The ROV video obtained during EX-15-04-L2 recorded at least 334 different types of organisms, extended the depth range of known communities of high-density coral and sponges at three sites, and discovered new high-density communities at six other sites. EX-15-04-L2 mapping operations mapped over 29,900 km<sup>2</sup> of seafloor, including two seamounts inside PMNM and one just outside of the boundary that had not been previously mapped. Important sub-bottom profiler data were also obtained below the seafloor of an enigmatic crater and the summit of an unnamed guyot believed not to be part of the Hawaiian seamount chain.

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## 1. Introduction

The NOAA Office of Ocean Exploration and Research (OER) is the only U.S. federal program dedicated to exploring our deep ocean, closing the prominent gap in our basic understanding of U.S. deep waters and seafloor, and delivering the ocean information needed to strengthen the economy, health, and security of our nation. Using the latest tools and technology, OER explores previously unknown areas of our deep ocean, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, OER allows scientists, resource managers, students, members of the general public, and others to actively experience ocean exploration—expanding available expertise, cultivating the next generation of ocean explorers, and engaging the public in exploration activities. From this exploration, OER makes the collected data needed to understand our ocean publicly available, so we can maintain the health of our ocean, sustainably manage our marine resources, accelerate our national economy, and build a better appreciation of the value and importance of the ocean in our everyday lives.

NOAA Ship *Okeanos Explorer (EX)* is the only U.S. federal vessel dedicated to exploring our largely unknown ocean for the purpose of discovery and the advancement of knowledge. America's future depends on understanding the ocean. Exploration supports NOAA mission priorities and national objectives by providing a broad diversity of data and information about the deep ocean to anyone who needs it.

In close collaboration with government agencies, academic institutions, and other partners, OER conducts deep-sea exploration expeditions using advanced technologies on *EX*. From mapping and characterizing previously unseen seafloor to collecting and disseminating information about deep waters and seafloor—and the resources they hold—this work establishes a foundation of information and fills data gaps. Data collected on the ship adhere to federal open-access data standards and are publicly available shortly after an expedition ends. This ensures the delivery of reliable scientific data needed to identify, understand, and manage key elements of the ocean environment. As the only federal program dedicated to ocean exploration, OER is uniquely situated to lead partners in delivering critical deep-ocean



information to managers, decision makers, scientists, and the public—leveraging federal investments to meet national priorities.

## 2. Project Background

### 2.1 CAPSTONE: The Campaign to Address Pacific Monument Science, Technology, and Ocean Needs

CAPSTONE: The Campaign to Address Pacific Monument Science, Technology, and Ocean Needs, was a three-year effort designed to provide critical new information on the deepwater resources within the U.S. National Marine Monuments and Sanctuaries located throughout the Pacific. The primary goal of all *EX* expeditions in this campaign was to obtain baseline data and information of the poorly known deepwater areas and resources in these extensive marine protected areas (MPAs).

### 2.2 2015 Hohonu Moana (EX-15-04) Expedition Overview

All of the four 2015 expedition legs around the Hawaiian Archipelago and Johnston Atoll were considered a single expedition that was titled *2015 Hohonu Moana: Exploring Deep Waters off Hawai'i*. The expedition covered in this report was the fourth *EX* expedition of 2015 and was, therefore, named EX-15-04—with each cruise being considered an expedition leg designated by the expedition code followed by L and the leg number (e.g. EX-15-04-L1 for leg 1). The first of the CAPSTONE expeditions, *2015 Hohonu Moana*, was focused on two monuments: the Papahānaumokuākea Marine National Monument (PMNM) and the Johnston Atoll Unit (JAU) of the Pacific Remote Islands Marine National Monument (PRIMNM). The first leg, EX-15-04-L1, was a mapping only cruise to the JAU of the PRIMNM, and the three following legs, EX-15-04-L2, L3, and L4, were all combined remotely operated vehicle (ROV) and mapping cruises. EX-15-04-L2 focused on the PMNM while EX-15-04-L3 and L4 focused on the Main Hawaiian Islands (MHI) and the JAU of the PRIMNM, respectively. This report provides a summary of operations and findings from the second leg of this expedition: EX-15-04-L2.



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### 2.3 Rationale for EX-15-04-L2 Exploration of PMNM

The PMNM surrounding the Northwestern Hawaiian Islands (NWHI) is the largest contiguous MPA in the United States and one of the largest in the world. The Monument encompasses over 362,061 km<sup>2</sup> (in 2015, before expansion) and spans nearly 2,000 km northwest from the edge of Middle Bank past Kure Atoll, and is thereby larger than all of the country's national parks combined. With a spectrum of elevations ranging from abyssal depths greater than 5,000 m below sea level, to rugged small rock islands reaching 275 m above sea level, PMNM harbors diverse habitats—including pelagic basins, abyssal plains, seamounts, submarine escarpments, flat-topped banks, coral reefs, shallow lagoons, littoral shores, dunes, and dry coastal grasslands. Due to PMNM's vast geographic isolation, its ecosystems have remained largely protected from many of the human stressors that impact more populated areas and are among the most pristine in the world. The marine habitats of PMNM are estimated to be home to more than 7,000 species, 25% of which are endemic to the region, found nowhere else on the planet (Parras, T. 2016). Therefore, PMNM truly represents one of the major reservoirs of marine biodiversity on the planet.

The geology of PMNM is equally as fascinating. The Monument's seafloor is covered with volcanic platforms that provide a detailed record of the formation of the Hawaiian Archipelago and tracks the movement pattern of the Pacific plate over the last 30 million years. Many of the 52 volcanoes in the archipelago are terraced with drowned fossil reefs that have recorded sea level change and the subsidence history of the volcanoes. However, many aspects of the archipelago's history in the NWHI remain poorly documented. Even the most widely accepted conclusion that the volcanoes increase in age to the northwest is not without controversy, as several submarine features of PMNM have been dated back 60-90 million years to the Cretaceous period.

More than 98% of PMNM's seafloor lies below 100 m, the vast majority of which is completely unexplored. Manned submersibles and remotely operated vehicles operated by the Hawai'i Undersea Research Laboratory (HURL) have conducted a number of surveys of the deepwater geology and biology in the Monument. However, most of these have been much shallower than 1,500 m, and consequently its deepwater resources are poorly known. In 2003 and 2007, though, several very high-density coral and sponge communities were



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discovered at depths between 1,500-1,800 m. These communities were located within the 1,000-2,500 m manganese crust depth zone, where cobalt-rich ferromanganese (FeMn) crusts represent a vast mineral resource that will likely be targeted in the future by the deep-sea mining industry. The Hawaiian Archipelago lies along the eastern boundary of the Prime Crust Zone (PCZ), where the richest and most commercially valuable crusts in the world are believed to have formed. The dense coral and sponge communities discovered within the Monument boundaries are protected against future anthropogenic threats. However, it is clear that we need to acquire a greater understanding of these communities, such as where they are likely to exist, how they form, at what depths they are found, and what their species compositions are. Discovery of more of these communities within the Monument serves two purposes: (1) it provides invaluable data on the deepwater resources within the Monument's boundaries, and (2) it provides a proxy for unprotected communities that lie outside the Monument on manganese crusts.

### 2.4 Objectives for EX-15-04-L2 Exploration of PMNM

EX cruises are exploratory in nature, supporting a large number of objectives that are categorized as programmatic or scientific in nature. Typically, programmatic objectives (i.e., operations, telepresence, data management, education, and outreach) are common to all expeditions, whereas scientific objectives are specific to a particular cruise or set of cruises. Below are brief descriptions of the programmatic and science objectives for EX-15-04-L2.

#### 2.4.1 Programmatic Objectives

##### *a) Mapping and ROV Operations*

Mapping objectives were to collect high-resolution acoustic data from all three types of sonars that were installed on the EX at the time: EM 302 multibeam, EK60 echo sounder, and 3.5 kHz sub-bottom profiler. Mapping data were acquired during transits, as well as on specific targets identified by the science team. Data from these systems were processed onboard as quickly as possible in order to generate daily mapping products that supported ROV operations. Data quality was expected to be high, as a result of proper instrument maintenance, careful planning of the surveys, and appropriate calibration of the instruments. For example, standard operating procedures



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for the multibeam sonar were to obtain sound velocity profiles at regular intervals no longer than 3-4 hours using expendable bathythermographs (XBTs).

ROV objectives were to obtain high-quality video and sensor data on exploration targets to achieve the science objectives. This most often involved surveying benthic habitats and features in priority areas (e.g., deep corals and related benthic ecosystems, canyons, and seamounts), as well as occasionally surveying in midwater for water column organisms. Benthic surveys were not only used to characterize the habitats in each target area, but also to ground-truth the acoustic data with visual data (i.e., video). In 2015, the ROV was fitted with hydraulically-activated sample boxes that permitted ROV pilots to collect limited rock and biological specimens for the first time. EX-15-04-L2 was the test and trial cruise for this activity. Training of ROV pilots and navigators in the use of the ROV manipulators and new sample boxes was an additional objective of the expedition.

### *b) Telepresence*

Telepresence objectives were to provide real-time, high-quality video and audio during ROV dives to as wide a shoreside audience as possible. This audience included the general public, students, and researchers—the latter of whom were either passively watching or actively participating in the dives via teleconference or instant messaging. Telepresence was used to help achieve the science objectives by extending the science team well beyond those actually onboard the ship. Telepresence objectives also included the establishment of two new Exploration Command Centers (ECCs) in Honolulu, at the University of Hawai'i (UH) at Mānoa and the NOAA Inouye Regional Center (IRC), that helped to achieve the education and outreach objectives through live ship-to-shore events.

### *c) Data Management*

Data management objectives were to collect, process, distribute, and archive cruise data as quickly and efficiently as possible. Effective data management provided a foundation of publicly accessible information products to spur further exploration, research, and management activities; it also stimulated interest in the deep-sea environment and the excitement of exploration. Each year, new methods and new



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equipment, such as video encoders, are tried and tested in an effort to improve data management activities. In 2015, a data management objective was to create and test a new sample database needed to capture and archive sensors and other important types of data associated with the collection of physical specimens.

### *d) Education and Outreach*

Education and outreach objectives included the engagement of the general public in ocean exploration through live video and a variety of other web-based products, both during and after each cruise. Web content included topical essays, daily updates, web logs, highlight videos, still imagery, and mapping products—all of which were posted on the *EX* website (<http://oceanexplorer.noaa.gov/oceanos/welcome.html> (Last accessed June 2020)). Other education and outreach objectives included ship tours for journalists, students, and VIPs while the ship was in port in Honolulu, and Reddit Ask Me Anything (AMA) events during the expedition. Educational experiences were also achieved through school tours to ECCs during live broadcasts, as well as public presentations by science team members after the cruises were completed.

## 2.4.2 Science Objectives

### *a) Mapping objectives*

The mapping objectives for EX-15-04-L2 involved both transit mapping to fill in bathymetric coverage holidays in existing data, and targeted mapping of specific features. These included areas just outside of the PMNM boundary such as Salmon Bank and the north Gardner and Rogatien rift zone ridges. In addition, two features inside the Monument boundary, the Maro reef Crater and an unnamed seamount east of Pearl and Hermes Atoll, were also targeted for subbottom profiling (SBP) surveys in order to help elucidate their geologic origins.

### *b) Discovery and baseline characterization of large-scale, high-density deep-sea coral and sponge communities within and outside the Monuments*

This objective was based on the premise that large-scale, high-density coral and sponge communities are among the most important deep-sea communities to protect against anthropogenic disturbance, and thus are important deepwater biological resources. In



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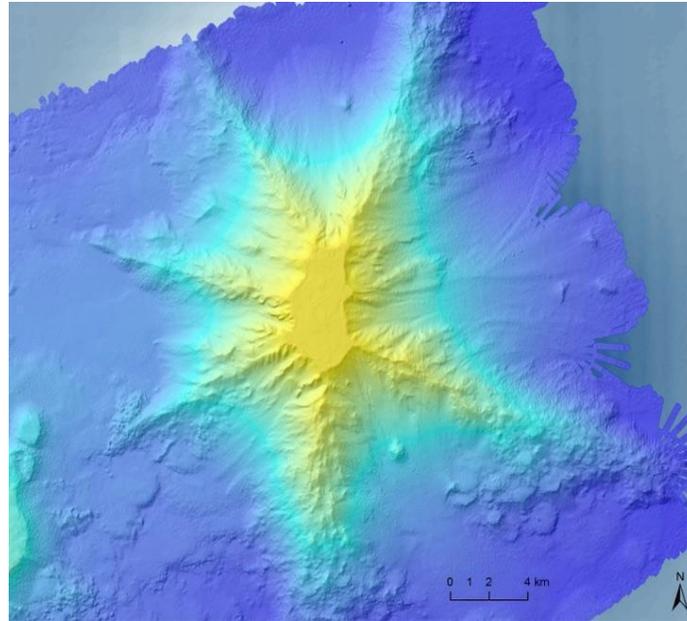
the central Pacific, only a small number of these communities with linear extents exceeding 1 km in distance had been discovered. These could be categorized into 1) shallower precious coral communities (i.e., 350-550 m) and 2) deeper non-precious coral and sponge communities (i.e., >1,000 m). A number of precious coral communities have been well documented within the Hawaiian Archipelago, particularly in the MHI, due to the availability of submersibles operated by HURL for the last 30 years. However, the few known deeper non-precious coral communities have not been well documented. Critical information on the lower depth limit of deep-sea communities is missing, since these communities extend below the maximum HURL submersible operating depth of 2,000 m.

Within each of these two types of communities, a few species of corals and sponges were common to most, if not all, but many other species were not, which resulted in each community having a unique faunal composition. Knowing the variability—both within and between these communities—is critical to understanding how they form, where they form, and how best to protect them.

### *c) Exploration of ridges as potentially suitable topography for the development of large-scale, high-density coral and sponge communities*

Deep-sea corals and sponges are obligate filter-feeding animals. The efficiency by which they feed and grow is believed to be directly related to the direction and velocity of bottom currents, which in general are moving laterally across the seafloor. For this reason, these animals are often found where bottom currents are accelerated, such as around obstacles in the path of the currents, or where there are constriction points, such as within channels. It also follows that for large communities to develop, there need to be large areas where bottom currents are accelerated.

Rift zone ridges are a common feature of many seamounts. To date, all large-scale, high-density coral and sponge communities in the central Pacific have been discovered over this type of topography. **Fig. 1** shows an example of a seamount having six of these ridges radiating out in different directions from the central summit area.



**Figure 1.** Unnamed seamount east of Pearl and Hermes Atoll in PMNM.

Each of these ridges provides a consistently oriented barrier to bottom current flow for 10 or more kilometers of distance, which should result in topographically-induced upwelling and current acceleration. The dominant bottom flow component at depths below 1,000 m is the principal lunar semidiurnal tidal constituent ( $M_2$ ) tide (Carter, pers. comm.). It follows that the relative orientation of a ridge to the local direction of the  $M_2$  tide would influence the magnitude of topographically-induced upwelling, and thus the magnitude of current acceleration. We hypothesized that ridges perpendicular to the prevailing direction of bottom current flow would be one type of topography where large-scale, high-density coral and sponge communities are found. PMNM has some of the largest and longest ridge topography mapped to date in the Pacific, and therefore provided an excellent location to conduct this type of study.

*d) Surveying and characterizing manganese crust habitats and their communities within the PCZ*

The central Pacific has been designated as the PCZ, considered to be the most important location on the planet for potential mining of cobalt-rich FeMn crusts. The depth distribution for commercially valuable FeMn-crust mining is 800-2,500 m (Hein, Conrad, and Dunham, 2009). While mining of deep-sea nodules or crusts has not yet begun at a



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commercial scale, information from the International Union for the Conservation of Nature (IUCN) states that it is imminent, due to depleting terrestrial deposits of metals and other elements found in the crusts. The environmental consequences of deep-sea mining may be catastrophic to the benthic habitats and communities where operations take place, regardless of whether nodules or crusts are targeted. The habitats and communities potentially at risk from mining activities are poorly known in the vicinity of Hawai'i, and completely unknown in most other areas of the central Pacific where the PCZ is located. Acquiring a better understanding of these habitats and communities before commercial mining activities begin is crucial to help inform future management decisions and protect particularly important and sensitive habitats, such as large-scale, high-density coral and sponge communities.

### *e) Survey and characterize deep-water biological and geological resources within the Pacific Monuments and Sanctuaries*

At the time of the EX-15-04-L2 expedition, all U.S. Marine National Monuments were located in and around the PCZ and, therefore, aside from protecting many terrestrial and shallow-water marine species, are protecting deep-sea benthic habitats and communities from the potential destructiveness of deep-sea mining and any other human impacts in the future. FeMn-crust habitats and communities have only been surveyed during a handful of submersible dives in PMNM, which came after the unexpected discovery of high-density coral and sponge communities at depths of 1200-1800 m. Many additional surveys are needed in order to evaluate the extent of these communities in PMNM, as well as in other Monuments across the Pacific.

### *f) Discovery of potential new records and new species of corals and sponges and their associates*

The central Pacific is one of the most remote locations on Earth and, due to expense and logistical considerations, is also one of the least explored. As a result, it is believed that a large number of species have yet to be documented in this area, including new species and new records for the region. Their discovery and identification provide critical information for taxonomic relationships and species distributions, as well as provide new information that may lead to more accurate definitions of the world's biogeographical provinces. Due to their high abundance and diversity of organisms,



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large-scale, high-density communities in FeMn-crust depths are good places to look for new species and records.

## *g) Geologic History of Central Pacific Seamounts*

Central Pacific seamount chains have provided crucial information for the field of plate tectonics. The Hawaiian-Emperor seamount chain has been the most important of these for interpreting the movement of the Pacific Plate. Recently acquired multibeam data in the northern end of PMNM revealed that this chain appears to be intersecting with an older seamount chain that arose during the late Cretaceous, which complicates estimates of geologic age and mantle plume duration. Collection and analysis of rock samples will help to identify conclusively which seamounts in this area are of Hawaiian origin and which are not.

## 3. Methods

### 3.1. Equipment

#### 3.1.1 Sonars

At the time of EX-15-04-L2, *EX* had three scientific sonars that were operated simultaneously during mapping operations: 1) a Kongsberg Maritime 30 kHz (EM 302) multibeam system, 2) a Kongsberg 18 kHz (EK60) split-beam fisheries sonar, and 3) a Knudsen 3.5 kHz chirp SBP sonar.

The EM 302 multibeam sonar was used to collect seafloor bathymetry, seafloor backscatter, and water column backscatter. Backscatter represents the strength of the acoustic signal reflected from some target, whether that's the seafloor or bubbles in the water column. The EM 302 is a deep-water multibeam system designed to map in depths ranging from approximately 200-7,000 m.

The EK60 split-beam echo sounder was used to collect information about the water column, such as gas plume or seep sites, and to obtain information about biomass. The EK60 sonar is used as a quantitative scientific echosounder to identify water column



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acoustic reflectors—typically biological scattering layers, fish, or gas bubbles—providing additional information about water column characteristics and anomalies.

The Knudsen Chirp 3260 (3.5 kHz) SBP is a low-frequency sonar designed to provide echogram images of surficial geological sediment layers to a maximum depth of about 80 m below the seafloor. The SBP is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar is fundamental in helping geologists interpret the shallow geology of the seafloor.

XBTs were deployed to obtain sound velocity profiles to help calibrate the multibeam system and ensure accurate bathymetric mapping. The XBT type is the Deep Blue probe produced by Lockheed Martin Sippican. XBT operations were conducted every three to six hours, at an interval defined by prevailing oceanographic conditions to correct multibeam data for changes in sound speed in the water column, and were applied in real time using the Seafloor Information System (SIS). Sound speed at the sonar head was determined using a RESON sound velocity probe (SVP)-70 probe, and salinity measurements near the transducers were taken using the ship's flow-through thermosalinograph (TSG).

### 3.1.2 ROVs

*EX* is equipped with NOAA's custom-built, dual-body, 6,000-meter-rated ROV that is comprised of two interconnected vehicles: *Deep Discoverer (D2)* and *Seirios*. *Seirios* is directly cabled to the ship and is, therefore, subjected to the vertical movements of the ship from surface swell. *D2* is laterally tethered to *Seirios* and is, therefore, largely isolated from surface conditions.

*D2* has five high-definition (HD) cameras, five standard-definition cameras, and 24 light-emitting diode (LED) lights that bring 144,000 lumens to the seafloor—resulting in some of the highest-quality deep-sea footage in the industry. Four custom-built lighting swing arms allow for the position and angle of the light to be adjusted for optimal imaging. *D2* also has two manipulator arms, a Schillings Orion arm and a Kraft Predator arm. The Kraft arm is more dexterous and is outfitted with custom-built jaws that allow for delicate work like sample collection, detaching small sample fragments, and equipment



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deployment or recovery. The Orion arm is used as a backup; this arm is also outfitted with the color calibration card. At the beginning of each dive, the HD video cameras on *D2* are color-corrected and white-balanced with the use of this card.

*Seirios* has one HD camera, five standard-definition cameras, and 18 LED lights that add 108,000 lumens to *D2*'s lighting. The vehicles work in tandem, with *D2* surveying the seafloor, and *Seirios* providing additional lighting and situational awareness, as well as dampening the movement of the ship. Both vehicles have a Sea Bird 9/11+ CTD with dissolved oxygen (DO) sensors.

## 3.2. Operations

During all CAPSTONE expeditions, *EX* operations were conducted continuously around-the-clock and involved either 24-hour-per-day sonar mapping (i.e., mapping only cruises) or both sonar mapping and ROV dives. For dive planning purposes, existing gridded bathymetry data were viewed in collaboration with the onshore science team as the ROV was being recovered each day. Dive tracks for the next day were then planned, plotted in 3D, and shared with the onboard and shoreside teams prior to the next dive.

### 3.2.1 Onboard Operations

On this ROV and mapping cruise, mapping operations were initiated as soon as the ship left port and continued each day as soon as the ROVs were secure on deck around 1700. Mapping continued throughout the night until the ship arrived on the next dive site, generally around 0600. Transit surveys were conducted to fill as many data gaps as possible while still ensuring the ship arrived at the dive site on time. Site surveys were conducted at a number of locations when permitted by a shorter transit between dive sites. The mapping and science leads worked together to develop the mapping line plans for these sites, since these surveys in particular were carried out in support of science objectives.

All three sonars were operated simultaneously during mapping operations, with the acquisition of multibeam data generally being the priority for line planning. However, at several sites—two guyots and a crater— the priority was collecting the SBP data. During two other dives while midwater transects were being conducted, the priority was to



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collect EK60 data during ROV ascent. Sound velocity profiles were obtained with XBTs every few hours as standard protocol to ensure the quality of the multibeam data.

ROV operations were conducted during daylight hours, generally starting with the ship arriving on site at 0600, the ROV entering the water around 0830, and the ROV exiting the water around 1630. This schedule generally yielded approximately eight hours of video per dive that included both midwater and seafloor footage, the proportions of which depended on time spent during descents and ascents. CTD data were collected during each dive via the CTD sensors onboard both the *Seirios* sled and *D2*. Both geological and biological samples were collected during the seafloor portion of each dive using *D2*'s manipulators. These samples were placed into the sample boxes and retrieved by the onboard science team after the ROV had been secured on deck. Samples were processed immediately in the ship's lab, the protocol for which is described below in section 3.3.3.

### 3.2.2 Shoreside Operations

The current operating model for *EX* cruises is based on telepresence-enabled participation whereby the small onboard science team is augmented by a much larger shoreside science team located around the world. When this model was first implemented from 2010 to 2012, all of the shore-based scientists were co-located at only a few ECCs around the U.S. (and occasionally in other countries), where they actively helped in the planning and execution of dives. This first effort was called the core participation model because it only accommodated a limited core group of shoreside participants. Subsequently, this model was replaced by a distributed participation model when the ship's video and audio communication became accessible from any location with an Internet connection (Elliott 2014). This enabled many geographically-dispersed scientists to actively participate in the dives from their home institutions or even their own homes. In this paradigm, digital communications such as email and instant messaging replaced person-to-person discussions and idea exchanges that naturally occur when a group is stationed together. The benefit of this distributed model was that the size of the science team was much larger.

For CAPSTONE expeditions, a hybrid of the core and distributed models occurred. In this case, shoreside participation involved small core teams stationed across the country in



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ECCs in addition to a larger geographically distributed team. This hybrid participation model still benefited from the information exchange and collaboration networks that developed during the use of the distributed model. However, it also benefited from the advantages of having ECCs that included higher Internet2 speeds, the means to simultaneously display all of the video feeds being sent off the ship, and direct interaction between the scientists participating at ECCs. This model is particularly effective for *EX*'s exploration.

## 3.3. Data Collection

The categories of data collected during all CAPSTONE expeditions included 1) sonar data from all three types of sonars, 2) video data from the various cameras mounted on *D2* and *Seirios*, 3) samples collected during the dives and sample data recorded while the samples were being processed, 4) environmental and tracking data from the CTDs and Tracklink system on *D2* and *Seirios*, and 5) biological and geological observations from participants that were captured on the dive audio or in the Eventlog. Survey of opportunity data were also collected when time and resources allowed in order maximize the scientific benefit of the cruise. Additional details about surveys of opportunity supported during EX-15-04-L2 are provided in section 3.3.6 and Appendix A.

### 3.3.1 Sonar data

Throughout each cruise, multibeam data quality was monitored in real time by acquisition watch standers. Line spacing was planned to ensure 25-30% overlap between adjacent lines of multibeam sonar swaths. Cutoff angles in SIS were generally set between 60° and 70° on both the port and starboard sides. Ship speed was adjusted to maintain data quality as necessary and as transit time to the next dive site allowed. All multibeam sonar data collected during the expedition were fully processed according to established onboard procedures and was archived with NOAA's National Center for Environmental Intelligence (NCEI). Additional details about data archival can be found in Section 5 of this report. Raw multibeam bathymetry data files were acquired by SIS, and were imported into Teledyne Computer Aided Resource Information System (CARIS). In CARIS, attitude and navigation data stored in each file were checked, and erroneous soundings were removed using CARIS Swath Editor and Subset Editor. Once per day, cleaned, gridded bathymetric data were exported to ASCII text files (y,x,z) at 50-meter



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cell size in World Geodetic System 1984 (WGS84 datum). The ASCII files were then used to create Fledermaus Scientific Data (SD) objects. These SD objects were then exported to Geotiff and Google Earth Keyhole Markup language Zipped (KMZ) files, which were copied to the shoreside file transfer protocol (FTP) on a daily basis to support shoreside scientist participation. For more detailed information about the sonar systems, see the ship's 2015 Survey Readiness Report, which can be obtained by contacting the NOAA Ship *Okeanos Explorer* Mapping Team ([oar.oer.exmappingteam@noaa.gov](mailto:oar.oer.exmappingteam@noaa.gov)).

### 3.3.2 Video Data

The primary data set collected during the EX-15-04-L2 ROV dives was HD video, which was recorded and archived in several different formats and resolutions. The dives were recorded in their entirety at 720p, five megabit-per-second (Mbps). In addition to the full dive recording, a subset of the video collected was preserved in ProRes 4.2.2. 1080i, 145 Mbps. These ProRes highlight clips were selected by the onboard videographers to capture the seafloor habitats and features imaged any time the ROV slowed, stopped, or zoomed in to take a closer look at a feature of interest; features and habitats of interest to the participating science team; and other "best of" imagery. The video clips were time coded to Universal Time Coordinated (UTC) time to coordinate with all data products collected on the ship.

In addition to the video itself, at least one frame grab was taken from each ProRes clip that was representative of that video segment for the purpose of discoverability. ProRes clips were then compressed for archiving.

### 3.3.3 Samples and Sample Data

EX-15-04-L2 was the first cruise during which geological samples and biological voucher specimens were collected. These collections were carried out to improve scientific understanding of PMNM's geologic history and its deepwater fauna. Until EX-15-04-L2, OER had operated under a no sampling policy for telepresence-enabled ROV operations on *EX*, pending completion of an open-access sampling protocol. Although this protocol was still being developed, a limited number of rocks and deepwater animal samples were collected due to high interest by NOAA and academic scientists and managers.



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These were limited to very selective, exploratory specimens that had the potential to contribute significant scientific discoveries.

Sampling was generally constrained to two rocks and two biological specimens per ROV dive, the latter of which were primarily pieces of corals and sponges. This constraint was imposed primarily as an effort to balance the way dive time was used for collecting, close-up imagery, and surveying. Only biological specimens suspected of being new species or new records for Hawaiian waters were targeted, and only pieces or small branches of larger animals were removed. Loose basalt rocks were targeted that had a minimal amount of attached organisms and FeMn crust. Both rocks and biological specimens were collected using the *D2*'s Kraft manipulator and placed into custom-designed retractable collection boxes located at the front of the vehicle (**Fig. 2**). At the time of collection, a Scientific Computer System (SCS) snapshot was taken in the control room that provided the date, time, latitude, longitude, depth, temperature, DO concentration, and identification for each sample. This data snapshot was used both to create sample labels on waterproof paper that would physically accompany the sample, as well as to populate the fields in the database record for that sample (see below).

Once *D2* and *Seirios* had been recovered and secured on deck, the onboard science team removed the samples and carried them into the ship's lab for immediate processing. All samples, both rocks and biological specimens, were first photographed with their labels and a size scale to document their initial appearance and condition prior to being dried or being placed in preservative (**Fig.2**). Any commensal organisms found on either the rocks or biological specimens were then separated and documented. Rocks were weighed and placed into a tray with their labels for drying, while biological specimens were preserved in ethanol. Just prior to preservation, a small aliquot was removed from many of the biological specimens for genetic analysis. Each aliquot was processed according to a protocol and using a kit provided by researchers with the Ocean Genome Legacy (OGL) Center at Northeastern University.

NCEI personnel created a Microsoft (MS) Access database specifically for recording the collection data for each of these biological and geological samples. The database was named the Sampling Operations Database Application (SODA) and its fields were populated for each sample as it was being processed in the ship's lab. Collection data



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included the information provided in the SCS snapshot along with cruise and dive numbers, sample condition, subsample identifications including OGL vial numbers, commensal organisms that were removed from each sample, the weight of the rock samples, and sample photo numbers.

At the end of the cruise, the science team lead, took custody of the rocks and biological specimens, transporting them to his laboratory at the University of Hawai'i, which served as a staging area for shipping the samples to their final repositories. Once there, all of the labels for the rocks and specimens were cross-checked with the data captured in SODA. Following this step, the ethanol in each of the biological specimens was refreshed and selected sponges and corals were then split, so one piece would remain in the Hawaiian Islands at the Bernice Pauahi Bishop Museum, while the larger piece would be sent to the National Museum of Natural History (USNM), Smithsonian Institution. All biological specimens were subsequently provided to these two repositories. The rock samples from all three EX-15-04 cruises were crated together and shipped to the Oregon State University (OSU), where they were incorporated into the NOAA collection within the OSU Marine and Geology Repository (MGR) (<http://osu-mgr.org/noaa-ex/>) (Last accessed June 2020).



**Figure 2.** *Left:* Manipulator arm and sampling box of the ROV *Deep Discoverer*, which were used to collect samples during ROV seafloor surveys. *Right:* Processing of collected specimens in the wet lab of NOAA Ship *Okeanos Explorer*.



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### 3.3.4 Environmental and tracking data

The *D2* environmental data collected during each dive were provided to the OER archive as raw Seabird .hex files. The *D2* tracking data were exported from Tracklink as text files. In order to make these data types more accessible to interested researchers, the science team processed all CTD and tracking data and merged them together in comma-separated values (CSV) files. These files were provided to both OER and NOAA's Deep Sea Coral Research and Technology Program (DSCRTP) for distribution.

### 3.3.5 Eventlog

During ROV dives, participating researchers communicated between ship and shore using the Eventlog. The Eventlog is a persistent chat room where all comments, discussions, and requests are logged and provided a UTC timestamp that can later be correlated to the operations, location, and data feeds collected by the ship. The chat server facilitated the first-order annotation of cruise activities, serving as a digital version of scientists' daily logs and enabling input from multiple users. Eventlog users were encouraged to use codes, which were three to five letter shorthand codes that were used to standardize and speed up the recording of observations in the Eventlog. The most current set of dive codes can be found

at: <http://oceanexplorer.noaa.gov/oceanos/collaboration-tools/im-eventlog/dive-codes.html>

### 3.3.6. Survey of Opportunity Data

#### **National Aeronautics and Space Administration (NASA) Maritime Aerosol Network (MAN)**

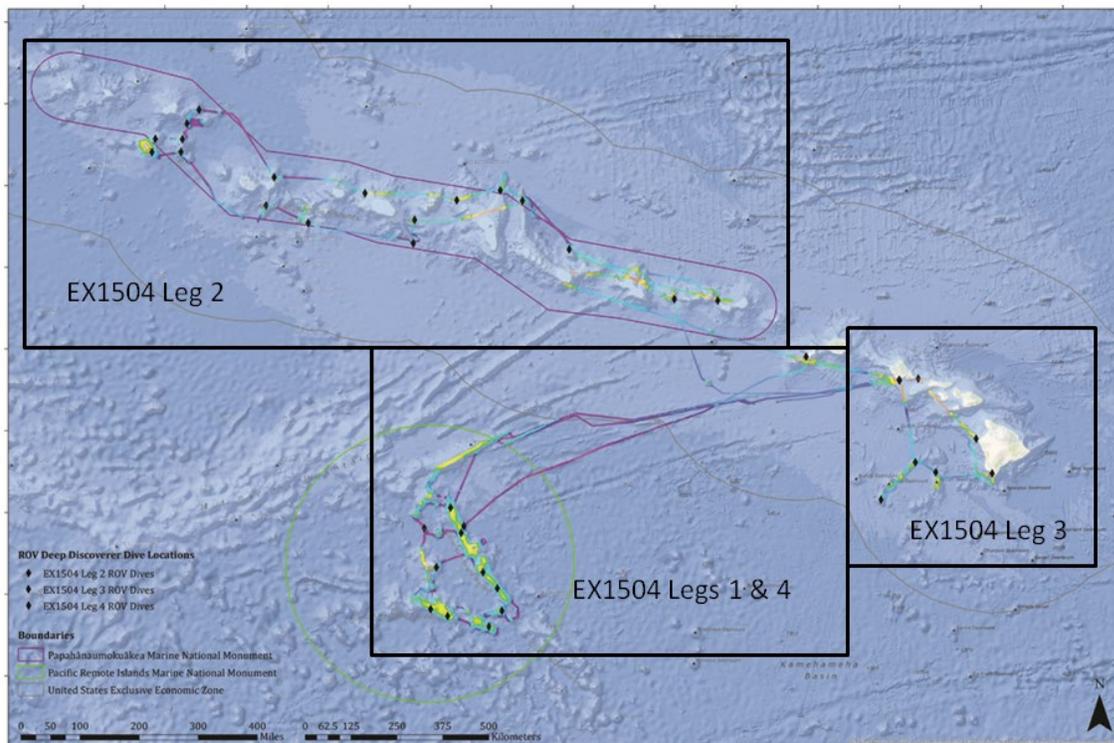
During all three EX-15-04 cruises, data were collected as time allowed for the NASA-led, long-term MAN research effort. Observations were made by mission personnel (as time allowed) with a sun photometer instrument provided by the NASA MAN program. Resulting data were delivered to the NASA MAN primary investigator Alexander Smirnov by the expedition coordinator. All collected data were archived and made publically available at: [http://aeronet.gsfc.nasa.gov/new\\_web/maritime\\_aerosol\\_network.html](http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html) (Last accessed June 2020).



The full survey of opportunity description is available in Appendix A.

## 4. Results

**Fig. 3** provides an overview image of the mapping and ROV operations during the *2015 Hohonu Moana* expedition. A total of 85,700 km<sup>2</sup> of seafloor was mapped and 37 ROV dives were completed in the MHI, PMNM, and JAU of the PRIMNM. Below is the summary of operations and findings for EX-15-04-L2, the second 2015 cruise conducted for this expedition.



**Figure 3.** Summary of the mapping and ROV dives conducted during the 2015 Hohonu Moana expedition.



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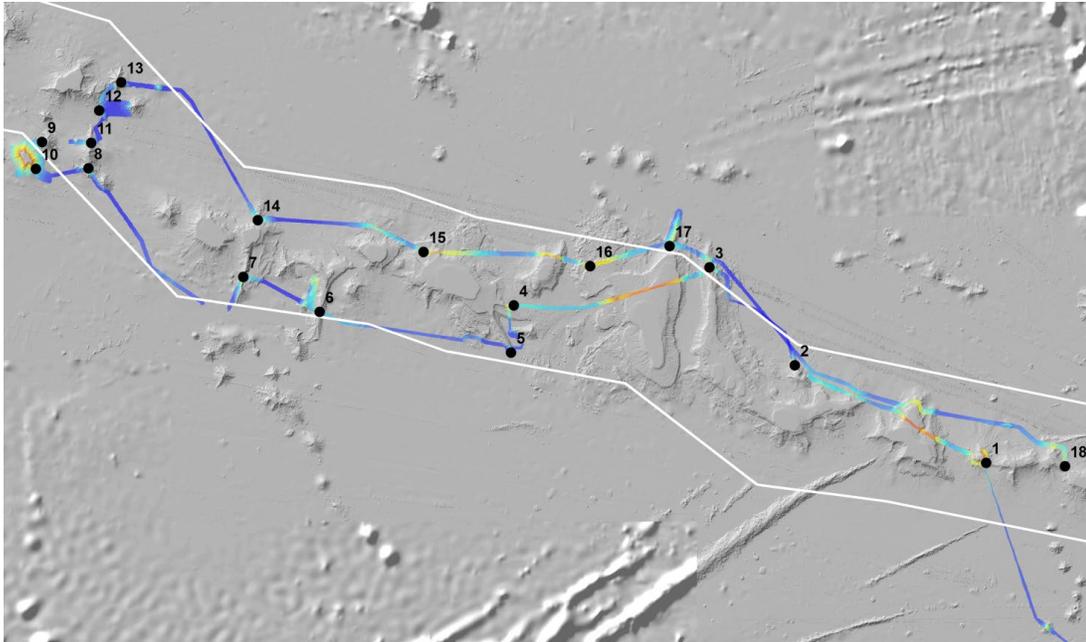
### 4.1. EX-15-04-L2 Operations

EX-15-04-L2 was the first telepresence-enabled ROV and mapping cruise using *EX* in the central Pacific region. The cruise plan called for the ship to spend a total of 23 days at sea, from July 31 to August 22, 2015, in which 20 ROV dives and nighttime mapping were planned to be conducted by the team. After departure from Pearl Harbor on July 31, the Commanding Officer (CO) was informed of military training exercises that required the ship to detour south, resulting in the cancellation of the first dive planned for the Middle Bank. On August 20, one day before the last planned dive for Middle Bank and two days prior to the ship's return to Pearl Harbor, the Commanding Officer received orders from NOAA's Office of Marine and Aviation Operations (OMAO) to head back to French Frigate Shoals (FFS) to evacuate four shore-based scientists, who were in the path of Tropical Storm Three-C. As a result, the last ROV dive was cancelled and the expedition's arrival to Pearl Harbor was delayed for one day. Therefore, EX-15-04-L2 ended on August 23, 2015, after 24 days at sea, during which 18 of the 20 planned ROV dives were completed. **Fig. 4** provides a map showing the locations of these dives and **Table 1** provides a calendar of events for each dive supported by the summary statistics for each dive found in **Table 2**.

Aside from three days of transit to and from the PMNM, all of the cruise time was spent on work conducted either inside the Monument or just outside the boundary in support of Monument interests.



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**Figure 4.** Map showing the locations of the 18 ROV dives conducted during the EX-15-04-L2 expedition to the PMNM.

## 4.1.1 Calendar of Events

**Table 1.** Calendar of Events during EX-15-04-L2

Date	Location	Operations
31-Jul-15	Pearl Harbor, O’ahu	Start of Cruise & Transit Mapping
01-Aug-15	Transit to “East Necker Seamount”	Transit Mapping
02-Aug-15	“East Necker Seamount (Keoia Seamount)”	ROV Dive 01 & Transit Mapping
03-Aug-15	“North FFS Seamount (Kanehunamoku Seamount)”	ROV Dive 02 & Transit Mapping



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04-Aug-15	“St. Rogatien Rift Zone Ridge”	ROV Dive 03 & Transit Mapping
05-Aug-15	“Maro Crater”	ROV Dive 04 & Transit Mapping
06-Aug-15	“Southeast Maro Ridge”	ROV Dive 05 & Transit Mapping
07-Aug-15	West Northampton Seamount Ridge	ROV Dive 06 & Transit Mapping
08-Aug-15	“Pioneer Bank Ridge”	ROV Dive 07 & Transit Mapping
09-Aug-15	“Bank 9 South”	ROV Dive 08 & Transit Mapping
10-Aug-15	East Salmon Bank	ROV Dive 09 & Transit Mapping
11-Aug-15	Salmon Bank Southeast Ridge	ROV Dive 10 & Transit Mapping
12-Aug-15	“Bank 9 North”	ROV Dive 11 & Transit Mapping
13-Aug-15	“Southeast Pearl and Hermes”	ROV Dive 12 & Transit Mapping
14-Aug-15	“Unnamed Seamount East of Pearl and Hermes Ridge”	ROV Dive 13 & Transit Mapping
15-Aug-15	“North Pioneer Ridge”	ROV Dive 14 & Transit Mapping
16-Aug-15	“North Maro Ridge”	ROV Dive 15 & Transit Mapping
17-Aug-15	“Gardner Terrace”	ROV Dive 16 & Transit Mapping
18-Aug-15	“East North Gardner”	ROV Dive 17 & Transit Mapping



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19-Aug-15	Transit to West Nihoa	Transit Mapping
20-Aug-15	West Nihoa	ROV Dive 18 & Transit Mapping
21-Aug-15	Transit to French Frigate Shoals	Evacuated scientists from Tern Island
22-Aug-15	Transit to Pearl Harbor, O’ahu	Transit Mapping
23-Aug-15	Pearl Harbor, O’ahu	Transit Mapping and End of Cruise

## 4.1.2 EX-15-04-L2 ROV Dive Summary Table

Select information for ROV Dives conducted during EX15-04 L2 is provided as **Table 2**.

**Table 2:** Summary information of all ROV Dives from EX-15-04-L2

Dive No.	Location	Date	On Bottom Position	Off Bottom Position	Max Depth (m)	Length (HH:MM)	Focus
1	“East Necker Seamount”	8/2	23.22166783, -163.517516	23.22854467, -163.5197693	2,222	5:14	Mn Crust Coral & Sponge Communities, Ridge Topography
2	“North FFS Seamount”	8/3	24.435258, -166.094949	24.42903883, -166.092024	2,485	5:12	Mn Crust Coral & Sponge Communities, Ridge Topography
3	“St. Rogatien Rift Zone Ridge”	8/4	25.62638396, -167.239187	25.62627002, -167.2430606	2,156	5:46	Mn Crust Coral & Sponge Communities, Ridge Topography
4	“Maro Crater”	8/5	25.1599975, -169.8833313	25.16444699, -169.8760807	3,036	6:14	Mn Crust Coral & Sponge Communities, Ridge Topography
5	“SE Maro Ridge”	8/6	24.5838295, -169.912149	24.58570769, -169.9150287	4,831	2:56	Mn Crust Coral & Sponge



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							Communities, Ridge Topography
6	W Northampton Seamount	8/7	25.08165602, -172.4889135	25.08729067, -172.4909122	1,997	5:34	Mn Crust Coral & Sponge Communities, Ridge Topography
7	"Pioneer Bank Ridge"	8/8	25.50771267, -173.5221628	25.51068893, -173.5222209	2,118	4:01	Mn Crust Coral & Sponge Communities, Ridge Topography
8	"Bank 9 South"	8/9	26.822083, -175.6064973	26.83028807, -175.6079087	1,382	6:51	Mn Crust Coral & Sponge Communities, Ridge Topography
9	E Salmon Bank	8/10	27.14033933, -176.2318992	27.14345956, -176.2268417	2,285	5:48	Mn Crust Coral & Sponge Communities, Ridge Topography
10	Salmon Bank SE Ridge	8/11	26.816233, -176.3140837	26.81962505, -176.3169632	2,052	5:38	Mn Crust Coral & Sponge Communities, Ridge Topography
11	"Bank 9 North"	8/12	27.13306692, -175.5710284	27.12859917, -175.570878	2,158	5:39	Mn Crust Coral & Sponge Communities, Ridge Topography
12	SE Pearl & Hermes	8/13	27.51699304, -175.4594012	27.519006, -175.4627155	2,800	5:46	Mn Crust Coral & Sponge Communities, Ridge Topography
13	E Pearl & Hermes Seamount	8/14	27.8533545, -175.162918	27.8544465, -175.170102	2,306	3:50	Mn Crust Coral & Sponge Communities, Ridge Topography
14	"N Pioneer Ridge"	8/15	26.20103421, -173.3242816	26.19688095, -173.3263077	1,645	6:03	Mn Crust Coral & Sponge Communities, Ridge Topography
15	"N Maro Ridge"	8/16	25.81195461, -171.0977907	25.81399815, -171.089974	1,752	6:19	Mn Crust Coral & Sponge Communities, Ridge Topography
16	"Gardner Terrace"	8/17	25.63792327, -168.8497842	25.6452195, -168.8446625	1,564	6:33	Mn Crust Coral & Sponge



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							Communities, Ridge Topography
17	"E North Gardner"	8/18	25.88034275, -167.7812454	25.88729619, -167.7812821	2,086	6:28	Mn Crust Coral & Sponge Communities, Ridge Topography
18	W Nihoa	8/20	23.18416033, -162.456943	23.18077433, -162.4517593	1,599	4:24	Mn Crust Coral & Sponge Communities, Ridge Topography

### 4.1.3 Expedition Daily Logs

**July 31, 2015, Underway:** NOAA Ship *Okeanos Explorer* departed Pearl Harbor, O’ahu, this morning at approximately 0930 and got underway to commence Leg 2 of the *2015 Hohonu Moana: Exploring Deep Waters off Hawai’i Expedition*. Onboard personnel spent the day preparing, training, and familiarizing personnel with shipboard systems, while many of the shore-based scientists became familiar with telepresence tools and the new University of Hawai’i at Mānoa Exploration Command Center. Due to Navy testing in the vicinity of our first planned ROV dive site and long transit times, the first ROV dive of the expedition has been cancelled and the team will instead start with the second planned ROV dive at “East Necker Seamount (Keoia Seamount)”. The sonar systems were turned on after we departed port, and the ship is currently conducting mapping transit operations en route to the first ROV dive site, planned for August 2<sup>nd</sup>. Due to a problem with the satellite connection, the ship is functioning on reduced bandwidth, and, as a result, will only stream two video feeds to shore during this leg.

**August 1, 2015, Transit Mapping:** EX continued 24-hour exploration mapping while transiting to the first ROV dive site. The ship mapped an unnamed seamount and a collapsed caldera on the way. The shipboard team conducted safety drills and continued with system familiarization and preparations for the start of dive operations.

**August 2, 2015, Dive 01 “East Necker Seamount (Keoia Seamount)”:** The first ROV dive of the cruise was conducted on the southeast rift zone of a seamount east of Necker Island



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(Mokumanamana) to determine the lower depth range of a deep-sea coral and sponge community found in 2003 during a *Pisces* submersible dive by HURL. The lower end of the deep-sea coral and sponge community was observed, along with a dense deep-sea coral and sponge community and many pillow basalts. The Very Small Aperture Terminal (VSAT) connection to the satellite was poor in the morning going into the ROV dive, but by the afternoon a series of adjustments had been made and the connection was usable. At least 10 scientists participated from shore, including from the new University of Hawai'i at Mānoa ECC. Two rock samples were collected and onboard sample processing and data management is going well. Transit mapping was conducted overnight en route to the next ROV dive site. XBT casts with all three launchers have shown severe spikes in data using probes from different batches, likely indicating a connectivity issue of a larger system. The system is being troubleshooted. Data spikes were cleaned out before the sound velocity profiles were input into the multibeam acquisition system.

**August 3, 2015, Dive 02 "North FFS(Kanehunamoku Seamount)":** Mapping continued through the morning until reaching the dive site. Dive 02 was on a seamount north of the FFS with the objective of determining the lower depth range of a known dense coral and sponge community found in 2007 during a *Pisces* submersible dive. While the ROV did not quite reach the depth of the previous *Pisces* submersible dive conducted in the area (1,700 m), today's dive observations indicate that a dense coral and sponge community extends down to a depth of approximately 2,250 m in this area. Biological specimens were collected for the first time today (two corals and two rocks). More than a dozen scientists participated remotely in the dive, and the IRC ECC joined operations for the first time today. Mapping was conducted after the dive, during transit to the next ROV dive site. The ROV ascent CTD cast was applied to the multibeam data for the 11-hour data collection, as the XBT system is still not providing good data and continues to be troubleshooted by survey team.

**August 4, 2015, Dive 03 "St. Rogatien Rift Zone Ridge":** Overnight transit mapping and synthesis holiday fill lines were conducted en route to the ROV dive site. Data quality on all sonars was high. The XBT system is still recording data spikes and continues to be troubleshooted. The ROV CTD was used for the first half of overnight data collection. A second XBT cast was conducted later in the night, and minor spikes occurred and were cleaned out so the cast could be interpolated and applied. Dive 03 of the cruise was conducted on the



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east side of a large rift zone ridge north of St. Rogatien Bank, and documented a deep-sea coral and sponge community on a FeMn-encrusted seafloor. Four samples were collected during the dive—a sponge (possible cladorhizid), rock sample (FeMn-encrusted basalt) and two corals (black and isidid). The VSAT connectivity was much better today, and 15 scientists participated remotely in the dive from the University of Hawai'i (UH) ECC, IRC ECC, Harbor Branch Oceanographic Institute (HBOI) ECC, Silver Spring ECC, and their home institutions. The sampling data workflow is still being developed. The modifications to the data structure on the shipboard server have resulted in a rebuild of the ksync.

**August 5, 2015, Dive 04: "Maro Crater":** Dive 04 of the expedition was the deepest yet, starting at 3,035 m deep on the eastern ridge of a crater that is located east of Maro Reef, and surveyed to and along the top of the ridge. There were 19 scientists who participated from shore. The live feeds and Voice over Internet Protocol (VoIP) lines continue to experience dropouts, but remain usable, albeit frustrating. Overnight mapping included subbottom data collection over Maro Crater at the request of the shore based science team, and holiday fill lines over existing synthesis data—including over deep sections of two volcanic rift zones. Data management documentation and cross training is continuing.

**August 6, 2015, Dive 05 "Southeast Maro Ridge":** Dive 05 of the expedition was conducted on a ridge that is southeast of Maro Reef. This dive was the deepest conducted during this cruise and its objective was to explore biological communities at depths that have never previously been explored inside the Monument. There were 22 scientists who remotely participated in the dive. Overnight mapping consisted of transit holiday fill lines on the ridge extending southeast off Maro Reef/Maro Seamount. Data quality was good on all sonars, with the exception of SBP tracking over slopes at high transit speeds (10+ kts). A successful XBT cast was conducted using one handheld launcher and the older MK21 USB rack unit. Ascent CTD data from *D2* is still being applied to multibeam data for the first half of night operations.

**August 7, 2015, Dive 06 West Northampton Seamount Ridge:** Dive 06 of the expedition was located on a ridge extending south from West Northampton Seamount to look for high-density communities of corals and sponges on ridge topography. One coral and two FeMn-encrusted basalt specimens were collected during the dive. There were 15 scientists who



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participated remotely in the dive, despite it being the worst day during this cruise for ship-to-shore communications and connectivity. Overnight mapping operations initially focused on completing a section of mapping on the western side of Northampton Seamount, followed by transit mapping through the night en route to the ROV dive site. Two of three XBT launchers are now producing good casts with the older USB rack unit.

**August 8, 2015, Dive 07 “Pioneer Bank Ridge”:** Dive 07 of the expedition was conducted on a sharp ridge extending to the south of Pioneer Bank to survey an unknown area below previous *Pisces* submersible dives on the ridge in order to determine the lower depth limit of known communities of corals and sponges. The team determined that the dense community—seen by the submersible dives further upslope—extended at least 6 km down the ridge to where the dive was. This is clearly an important, large, high-density community of corals and sponges. Connectivity and communications challenges continued between the shore-based and shipboard science team. The conference call and connection to the chat room were dropped several times, and the shore-based team reported having issues with the video freezing. The issues with the VoIP may not necessarily be correlated to the VSAT dropouts, however, without a steady VSAT connection this is impossible to know for sure, and shoreside testing is recommended. Overnight transit mapping focused on complementing existing synthesis data where possible. XBTs have been good two nights in a row. The CTD data from the ROV ascent continue to be applied to the multibeam echosounder (MBES) data. Data management documentation is ongoing. The sample database has been—and continues to be—steadily updated and debugged.

**August 9, 2015, Dive 08 “Bank 9 South”:** Dive 08 of the expedition was conducted on a seamount on the south side of Bank 9 to explore for high-density communities of deep-sea corals and sponges and look for clues on how this peculiar composite seamount might have formed. There were 17 scientists who participated remotely. There were minor communication and connectivity issues, but the connection was better than on previous days, thanks to a low sea state. Overnight mapping focused on developing coverage over the Salmon Bank area in preparation for the ROV dive on 8/11. Troubleshooting and refinement of the sample database continues.



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**August 10, 2015, Dive 09 East Salmon Bank:** Overnight mapping focused on unmapped areas of Salmon Bank in preparation for the next morning's ROV dive site. Data quality on all sonars was high. Dive 09 was located on a sharp ridge that extended west from East Salmon Bank, and its objective was to survey for the presence of high densities of corals and sponges and examine the impact of ridge orientation on the presence of high-density communities. There were 17 scientists who remotely participated in the dive.

**August 11, 2015, Dive 10 Salmon Bank Southeast Ridge:** Overnight mapping efforts focused on the east and north flanks of Salmon Bank. Subbottom data were collected over the northwest Salmon Bank area. Dive 10 was conducted on a ridge that extends to the southeast of Salmon Bank, with the objective of surveying a completely unexplored area for corals and sponges. One rock (FeMn-crust), one sponge, and two corals (along with commensals) were collected during the dive; 16 scientists participated remotely. The ship-to-shore connection was improved, compared to previous days.

**August 12, 2015, Dive 11 "Bank 9 North":** Overnight mapping focused on filling a 700-km<sup>2</sup> bathymetric coverage holiday east of Pearl and Hermes Atoll. Data quality was good on all sonars. Dive 11 was conducted today on a modest ridge that extends north from the northern half of Bank 9 to explore for high-density communities of deep-sea corals and sponges along the ridge. There were 18 scientists who participated remotely in the dive. The connectivity today was the best yet during this cruise.

**August 13, 2015, Dive 12 "Southeast Pearl and Hermes Ridge":** Extensive work and troubleshooting was done with the VSAT and shore connection today. The phase combiner issue was exacerbated today when one of the power amplifiers on the VSAT experienced a failure, resulting in additional power (and therefore bandwidth) loss. Electronics Technician (ET) David Blessing went above and beyond, working with MTN (the satellite provider company) and ascending into the dome several times throughout the day. The requisite repairs cannot be enacted at sea and require parts be replaced in the VSAT power amplifier. As a result, the ship is now down to a 10 MB connection and a single video stream off of the ship. The MTN technician will meet the ship at the pier on August 22<sup>nd</sup> and will be ready to start repairs—replacing the amplifier module with a loan unit in Hawai'i. The expected time to complete the repairs is two full days.



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Dive 12 of the expedition was conducted along the western edge of a rift zone ridge extending southeast from Pearl and Hermes Atoll. The objective of the dive were to explore for high-density communities of deep-sea corals and sponges along the edge of the ridge crest, to obtain information on the lower depth range of these communities, and to document nekton and gelatinous megaplankton in the water column during the ascent to the surface. No video was streamed to shore during the vast majority of the dive and the conference line was dropped on several occasions. A single video feed was restored towards the end of the water column transect portion of the dive. There were 13 scientists who attempted to participate remotely, but could not do so, due to loss of connectivity. EK60 data were collected during the water column exploration portion of the ROV ascent. Overnight mapping focused on focused subbottom data collection over the unnamed potentially Cretaceous seamount, which is the location of the August 14<sup>th</sup> dive.

**August 14, 2015, Dive 13 “Unnamed Seamount East of Pearl and Hermes”:** Dive 13 was conducted on a ridge that extends to the southeast of an unnamed seamount east of Pearl and Hermes Atoll to explore for high-density communities of deep-sea corals and sponges. There were 18 scientists who remotely participated using one HD video feed, instant messaging, and teleconference. The connection to shore was good with a few drops. The data transfer to shore seemed to keep up without impacting the single video stream. The full ksync profile is currently being allowed, but the data throughput is restricted to 125 Kbps/1 Mbps. Overnight mapping was conducted during the 10-knot transit en route to the next dive site via a path that diverted outside Monument boundaries to accommodate waste water disposal. An uncharted seamount rising approximately 2,818 m (8,800 feet) from the surrounding seafloor was mapped within the Monument boundary. The feature is 14.8 km wide across the northwest-southeast axis, pyramidal or conical in shape with a sharply defined peak and no long ridge features present. The seamount previously appeared in satellite-derived bathymetry, but was found to be 1500 m higher than predicted.

**August 15, 2015, Dive 14 “North Pioneer Ridge”:** Overnight mapping operations consisted of transit mapping over unmapped areas between dives 13 and 14. Dive 14 was conducted on a ridge that extends northward from Pioneer Bank to determine whether ridge



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topography is suitable for high-density communities of corals and sponges. Two rocks and two corals (and commensals) were collected. Eight scientists remotely participated in the ROV dive. Adjustments were made to the VSAT power amplifiers, so the ship now has a relatively stable (but sea-state dependent) 11 MB stream off of the ship. The primary *D2* ROV stream continues to be received well on shore; however, the team continues to test the ability to send a second usable stream at a reduced bitrate rate.

**August 16, 2015, Dive 15 “North Maro Ridge”:** Dive 15 of the expedition was conducted on a ridge located north of Maro Reef to survey a completely unexplored area for corals and sponges; this provided more information on whether high-density communities can be found on ridge topography and that the orientation of the ridge is important. Two FeMn-crusts rocks and two corals were collected during the dive, and 12 scientists participated remotely. Overnight mapping consisted of straight transit mapping between dive sites, with no time for holiday fill deviations from the direct transit track. The EM 302 showed what looked like interference for ~2 hours while climbing one side of a seamount. The morning built-in self-test (BIST) showed several hard failures and will be troubleshooted.

**August 17, 2015, Dive 16 “Gardner Terrace”:** Overnight mapping focused on developing coverage of the rift zone at Gardner Pinnacle, which extends outside of Monument boundaries. The multibeam transmit/receive unit (TRU) SIS software required two restarts before booting properly, then performed well all night. The daily BIST passed. Data on all sonars were high quality. Dive 16 was conducted on what is believed to be an old reef terrace edge north of Gardner Pinnacles. The objective of this dive was to survey the terrace edge, which is now a 200 m high narrow ridge, for corals and sponges, gathering information on whether high-density communities can be found on ridge topography. One sponge and one coral (along with commensals) were collected during the dive. There were 19 scientists who participated remotely in the dive.

**August 18, 2015, Dive 17 “East North Gardner”:** Dive 17 was conducted just outside the boundaries of the Monument on a ridge that extends north of Gardner Pinnacles to survey a completely unexplored area for corals and sponges, testing the hypothesis that high-density communities can be found on ridge topography. Water column transects were conducted during the ascent to the surface. EK60 data was collected during the water



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column transect. Animals present in the deep scattering layer at 500 m appeared to again avoid the ROVs. Two FeMn-crusts, two corals and two sponges (along with commensals) were collected during the dive and 15 scientists participated remotely. There were significant video degradation and dropout issues in the morning, accompanied by loss of the VoIP teleconference line. Occasional dropouts continued through the duration of the dive. Transit mapping to the dive site for Aug 20 commenced and will continue through 8/19 into the morning of 8/20.

**August 19, 2015, Transit Mapping to West Nihoa:** Today was a transit day as the ship continued a transit more than 330 nm to the south-eastern section of PMNM where a dive will be conducted tomorrow on a seamount to the east of Necker Island. Transit mapping continued throughout the day and into the morning of 8/20. Data quality on all sonars was high to acceptable at high transit speeds. While the mapping team was busy with data acquisition and processing, other onboard personnel used the transit day to catch-up on reports, make adjustments to the ROV, and plan for the next cruise leg of the expedition. The telepresence/video team continued post production training and dive highlight editing. The data management team continued documentation and preparation for EX-15-04-L2 demobilization, and dealt with a hardware failure. The E48\_01 Video storage array network (SAN) reported two failed redundant array of independent disks (RAID) volumes; a full backup to three external Drobo arrays for all cruise data (excluding mapping EM 302 .ALL & .WCD) was completed.

**August 20, 2015, Dive 18 West Nihoa:** Dive 18 was conducted today at a channel between Westpack Bank and Nihoa Island, which creates a constriction point for current flow. The dive was aborted halfway into the dive due to a very strong bottom current. One rock sample was collected and 12 scientists remotely participated in the dive. The data management team continued the rebuild of failed volume2 on E48\_01, and troubleshooted the shoreside repository locking up shortly after ROV deployment. Although the system's event log continued to be accessible, standard services (HTTP, FTP, SSH, VNC) were not. Due to the potential risk of a corrupt database with a hard reboot, we decided to hold off the reboot until the end of the final dive. Rsync of datasets to shore halted until noaasr1 is accessible.



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In the evening, OMAO ordered *EX* to divert course from her planned return to Pearl Harbor, O‘ahu, and instead transit west to Tern Island, FFS to evacuate four scientists conducting research for NOAA’s Hawaiian Monk Seal Research Program. These researchers were located on one of several camps in the Northwest Hawaiian Islands in the vicinity of the predicted route of Tropical Storm Kilo, which was forecasted to turn into a hurricane in the coming days. Tropical Storm Loke continued to develop to the west, coming in behind Kilo. These scientists were ordered to evacuate, and as the closest ship, *EX* was called to service.

**August 21, 2015, Called to Service:** Transit exploration mapping continued throughout the day and evening with a skeleton mapping crew. The EK60 was secured so the survey team could focus on multibeam and subbottom data collection. Due to the cancellation of the final dive, noaasrs1 was restarted Friday morning. Despite coming back from a graceful shutdown, the shoreside repository locked up again a few hours later. The telepresence lead will reboot the system again on August 22<sup>nd</sup>, and the data manager will disable active services while auditing the system logs. If necessary, we will fail over to noaasrs2 prior to the EX-15-04-L3 departure. High-priority datasets are being pushed to noaasrs2 for temporary access until stability issues with noaasrs1 are resolved. Documentation and demobilization preparations are continuing. The ROV team spent the day conducting maintenance and preparing the end of cruise documentation. In the evening, a small boat was deployed to Tern Island and four scientists were picked up and brought onboard. The ship then turned around and commenced transit back to Pearl Harbor, O‘ahu. Arrival is expected late Sunday (August 23<sup>rd</sup>) night or early Monday (August 24<sup>th</sup>) morning.

**August 22, 2015, Transiting Home:** 24-hour transit mapping was conducted as *EX* continued transiting back to Pearl Harbor, O‘ahu. A slight course deviation was made to map a portion of an uncharted seamount located within the boundaries of PMNM. The onboard team spent the day catching up on paperwork, finalizing cruise documentation and working on the end of cruise demobilization. The CO, Operations Officer, and mission personnel conducted a cruise debriefing meeting in the afternoon.

**August 23, 2015, Arrival in Pearl Harbor:** Transit mapping continued today until the ship reached the Pearl Harbor sea buoy, at which time sonars were turned off and *EX* made her way into port. By 1830 pm HST, the ship was moored at the pier on Ford Island and Leg 2 of



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the expedition was brought to a close. The team onboard spent the day finalizing documentation and reports, debriefing the cruise, and preparing for the in-port period before the next cruise.

### 4.1.4 Data Collected

Twelve terabytes (TB) of data were collected including multibeam, subbottom, EK60, CTD, video, images, and associated dive and video products. EX-15-04-L2 was a combined ROV and mapping cruise, and even though mapping only took place at night and during transit days, over 29,000 km<sup>2</sup> of EM 302 multibeam data were collected both inside and outside of PMNM boundaries. Knudson subbottom and EK60 water column data were obtained along the entire cruise track—which extended over 3,000 nm.

A total of 146 hours of video was recorded during the 18 ROV dives that ranged in depth from 1,198.6 m to 4,831.2 m. Of this, 98 hours were collected on the seafloor and eleven separate midwater transects (each consisting of 10 min) that were carried out during two of the ROV dives.

EX-15-04-L2 was the first cruise where physical samples and associated sampling data were collected. During this cruise, 96 samples (65 biological specimens and 31 rocks) and their associated collection data were acquired.

### 4.1.5 List of Participants

Participation on EX-15-04-L2 involved 21 at-sea mission personnel and 36 shoreside scientists engaging either by audio commentary or instant messaging via the cruise chat room on a regular basis. At-sea personnel included the expedition coordinator, mapping specialists, ROV engineers, video engineers, data specialists, and on-board scientists. Shore-based science team members participated from remote ECCs and from their home locations. Lists of these participants are provided in **Tables 3** and **4** below.

**Table 3: EX-15-04 Leg 2 At-sea Mission Personnel**

Name	Role	Affiliation
Elliott, Kelley	Expedition Coordinator	NOAA OER (Acentia)



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Lobecker, Elizabeth (Meme)	Mapping Lead	NOAA OER (ERT, Inc.)
Miller, James	Mapping Watch Lead	(ERT, Inc.)
Kelley, Christopher	Science Co-Lead	NOAA OER
Wagner, Daniel	Science Co-Lead	NOAA PMNM
Reser, Brendan	Data Engineer	NOAA NCEI (Riverside Technologies)
Drewniak, Jared	Video Engineer	NOAA National Coastal Data Development Center (NCDDC) Design Guide Implementation Team (DGIT)
Williams, Jeff	ROV Engineer	University Corporation for Atmospheric Research (UCAR)
Wright, Dave	ROV Engineer	UCAR
O'Brian, Andy	ROV Engineer	UCAR
Mohr, Bobby	ROV Engineer	UCAR
Lanning, Jeff	ROV Engineer	UCAR
McLetchie, Karl	ROV Dive Supervisor	UCAR
Smithee, Tara	Video Engineer	UCAR
Kennison, Sean	ROV Engineer	UCAR
Carlson, Joshua	ROV Engineer	UCAR



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Rogers, Dan	Video Engineer	UCAR
Howard, Art	Video Engineer	UCAR
Biscotti, Joe	Video Engineer	UCAR
O'Brien, Andy	Data Engineer	UCAR
Woodard, Katherine	Data Engineer	NCEI

**Table 4: EX-15-04 Leg 2 Shore-based Science Team**

Name	Affiliation	Email	Participation Location/Mode
Diva Amon	UH	divaamon@hawaii.edu	UH ECC/Chat
Amy Baco-Taylor	HBOI, Florida State University (FSU)	abacotaylor@fsu.edu	HBOI ECC/Audio & chat
Scott France	University of Louisiana at Lafayette (ULL)	france@louisiana.edu	ULL/Audio & Chat
Steve Haddock	Monterey Bay Aquarium Research Institute (MBARI)	haddock@mbari.org	MBARI/Audio & Chat
Santiago Herrera	University of Toronto &	sherrera@alum.mit.edu	UT/Chat



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Andrea Quattrini	U.S. Geological Survey (USGS)	aquattrini@usgs.gov	Chat
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Jonathan Tree	UH	jtree@hawaii.edu	UH ECC/Audio & Chat
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Randal Singer	Florida Museum of Natural History (FLMNH)	rsinger@flmnh.ufl.edu	FLMNH/Chat



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Michael Parke	IRC, NOAA	Michael.Parke@noaa.gov	IRC ECC/Audio
Charlotte Seid	Northeastern University (NEU)	c.seid@neu.edu	NEU/Chat
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Frank Parrish	IRC, NMFS Protected Resources Division (PRD)	Frank.Parrish@noaa.gov	IRC ECC/Chat
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Amanda Ziegler	UH	aziegler802@gmail.com	UH ECC/Chat
Dave Clague	MBARI	clague@mbari.org	MBARI/Audio
Mackenzie Garringer	UH	mgerring@hawaii.edu	UH ECC/Chat
Steve Auscavitch	Temple	steven.auscavitch@temple.edu	Temple/Chat
Walter Ikehara	IRC, NMFS	walter.ikehara@noaa.gov	IRC ECC/Audio & Chat
Asako Matsumoto	Tokyo, Planetary Exploration Research Center/ Chiba Institute of Technology (PERC/CIT)	amatsu@gorgonian.jp	Tokyo/Chat
Liz Shea, Delaware	Delaware Museum of Natural History (DMNH)	eshea@delmnh.org	DMNH/Chat



Mary Wicksten	TAMU	wicksten@bio.tamu.edu	TAMU/Audio
Tim Shank	WHOI	tshank@whoi.edu	WHOI/Audio & Chat

## 4.2 EX-15-04-L2 Findings

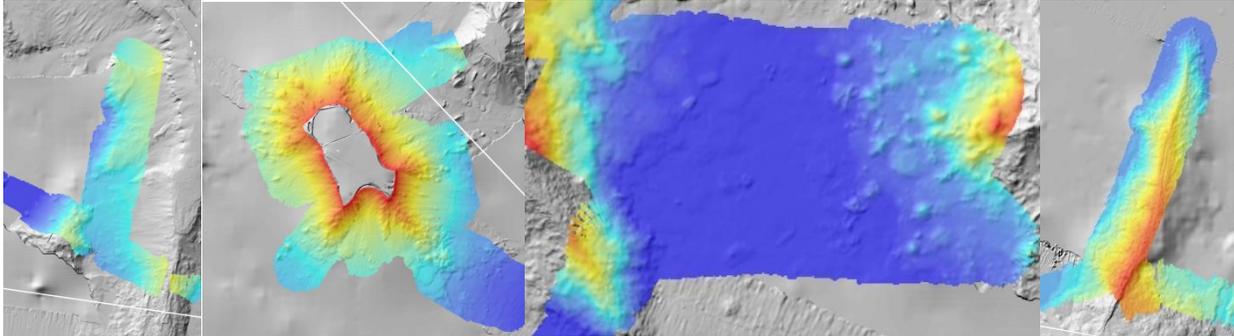
Below is a brief summary of the findings from this cruise broken into three categories: sonar, ROV, and environmental—the latter being restricted to data collected by the ROV CTD.

### 4.2.1. Sonar Findings

Data from the EM 302 multibeam system were of primary importance during mapping operations and included both targeted surveys and transit mapping. Targeted survey mapping was conducted for the purpose of either filling gaps in the existing coverage in and around PMNM, and for use in identifying ROV dive sites. Targeted surveys were conducted at four sites: (1) an area west of West Northampton Seamount, 2) Salmon Bank, 3) an area near Pearl and Hermes Atoll, and (4) the northeast rift zone ridge of Gardner Pinnacles that extends north outside of the Monument boundary. Of particular importance was the mapping conducted around Salmon Bank, since it is of considerable interest to PMNM management and was furthermore used to identify an ROV dive site on the bank. Also worth mentioning is the partial mapping of a small seamount west of West Northampton Seamount, which appears to be a deep guyot with a summit depth over 2,400 m. This feature may therefore be older than the surrounding Hawaiian seamounts and banks. The coverage obtained at these sites is shown in **Fig. 5**.

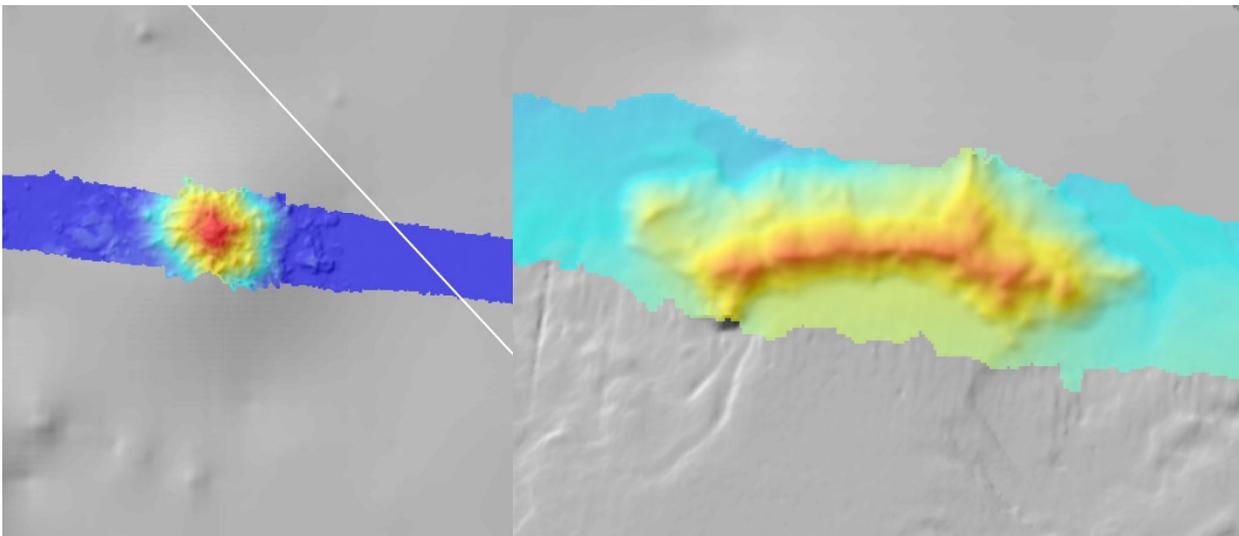


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**Figure 5:** Targeted multibeam survey mapping near West Northampton Seamount (left), Salmon Bank (middle left), near Pearl and Hermes Atoll (middle right), and North “Gardner Pinnacles” (right).

The most notable findings from the transit mapping were two previously unknown seamounts: a small conical seamount found east of Pearl and Hermes Atoll and a ridge type seamount found north of Twin Banks (**Fig. 6**). Both of these seamounts reach a height of greater than 1,000 m from the surrounding seafloor.



**Figure 6:** Two previous unknown seamounts discovered during transit mapping: a small conical seamount east of Pearl and Hermes Atoll (left) and a ridge type seamount found north of Twin Banks (right).

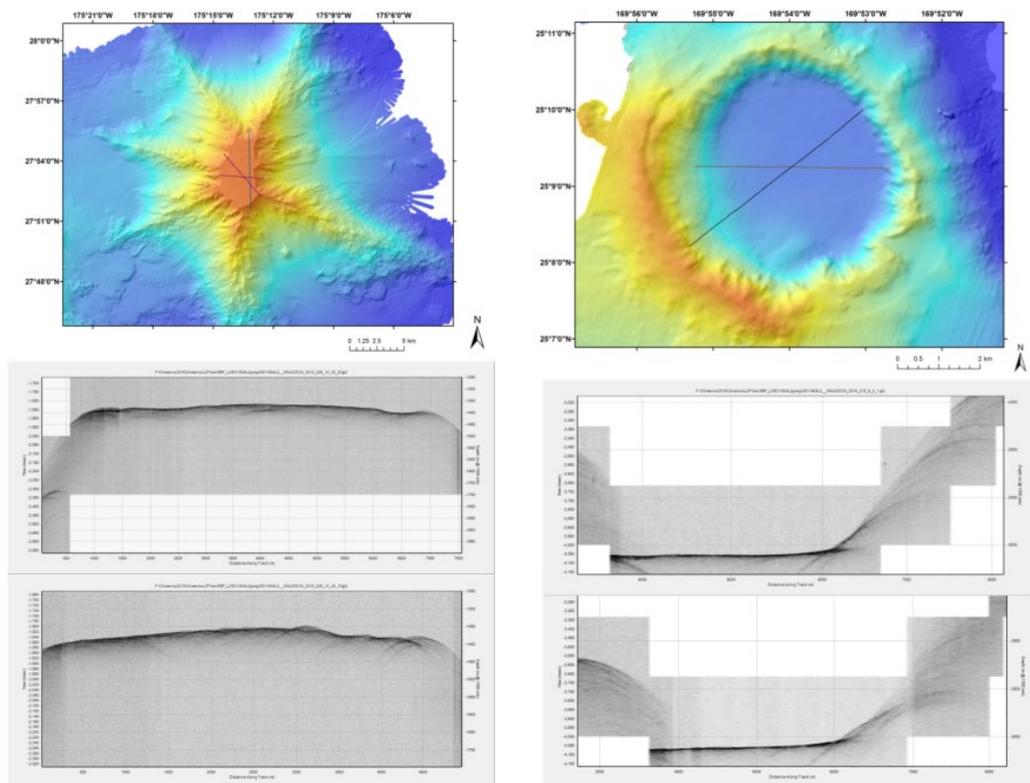
Knudson subbottom profiling took place along the entire cruise track; however, the most noteworthy data were collected during targeted surveys over an unnamed guyot east of Pearl and Hermes Atoll, which is believed to be of Cretaceous origin, and a large enigmatic crater east of Maro Reef. These surveys were conducted to obtain a better understanding of the amount of sedimentation present on the guyot summit and the



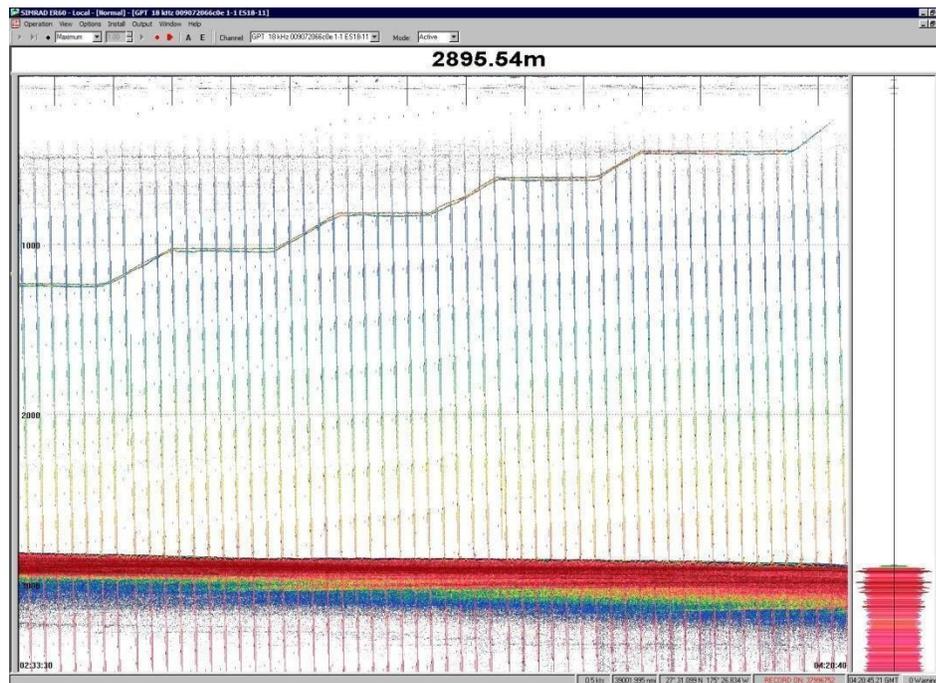
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floor of the crater. Both sites showed very little penetration indicating they have little to no sedimentation (**Fig. 7**).

EK60 data were collected along the entire cruise track and have not yet been processed or analyzed. However, of particular interest were observations made during midwater video transects that took place at the end of two ROV dives. A screen grab from the EK60 display during one set of these transects is provided in **Fig. 8**.



**Figure 7.** Subbottom survey tracks and profile images of a Cretaceous guyot east of Pearl and Hermes Atoll (left) and a large enigmatic crater southeast of Maro Reef (right).



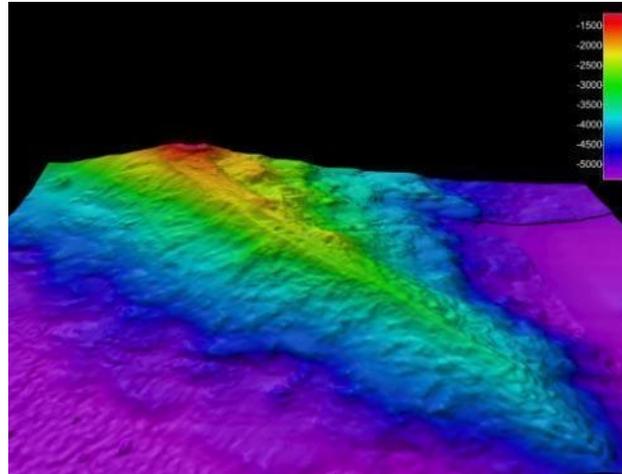
**Figure 8.** EK60 screen grab taken during the ascent from ROV Dive 17 while midwater transects were conducted. Interference (vertical lines) is the ultra-short baseline (USBL).

## 4.2.2. ROV Findings

Eighteen ROV dives were conducted during this cruise that yielded a total bottom time of 98:24:14 h and a linear survey distance of 6,211 km. Completed ROV dive summary forms for every dive are available in Appendix B. The dives targeted ridges extending from seamounts and banks in, or just outside of, the Monument at depths ranging from 1,198.6 m to 4,831.2 m (**Fig. 9**). Ridge crests are hypothesized by scientists to be suitable for the development of large, high-density coral and sponge communities because they provide consistently oriented topography (i.e., the crest runs in the same direction for long distances) where current flow is accelerated. We found that some ridge crests were suitable for the development of high-density coral and sponge communities and some were not, depending on such additional factors as depth, substrate consolidation, and possibly the geographic orientation of the ridge.



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**Figure 9.** Examples of a rift zone ridge extending southeast of Pearl and Hermes Atoll, which was chosen as an ROV dive site during EX-15-04-L2.

High-density communities of deep-sea corals and sponges (**Fig. 10**) were recorded on 10 of the dives, all of which were shallower than 2,500 m and had large sections of unbroken FeMn-crusts basalt that provided firm attachment substrate for corals and sponges. This brought the total number of known high-density communities in the Monument from three to ten, since three of the dives took place on each of the three known high-density community sites.



**Figure 10.** Left: A high-density community of deep-sea corals and sponges encountered at 2,078 m on the crest of Pioneer Bank Ridge during ROV Dive 7. Right: A high-density community of deep-sea corals encountered at 2,110 m on a seamount east of Pearl and Hermes Atoll during ROV Dive 13.



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There were 13 dives conducted on seamounts or banks that had never before been surveyed at any depth. One of these dives was on an enigmatic crater off the southeast coast of Maro Reef, whose origin had been a mystery since it was first discovered in 2002. The caldera of this crater is 5 km wide and 500 m deep from the shortest part of the rim. Without having analyzed the rock samples, it appears from the video that this crater was formed in a similar manner to those seen on other Hawaiian volcanoes. The crater is undraped by later volcanism and has well-preserved crater morphology. Thus, it is assumed to be a late-stage feature, like Diamond Head crater on O'ahu, although it is five times larger and its floor is 3,000 m below sea level. More work is needed to understand the origin of this enigmatic feature.

Three dives were conducted on what were believed to be Cretaceous seamounts (80-90 Ma), all of which are guyots (i.e., flat top tablemounts) that are thought to have already been present on the seafloor when the neighboring Hawaiian volcanoes formed 60 Ma later (Kelley et al, 2015). The last dive of the cruise was conducted on a ridge extending into a constricted channel between two banks, where current velocity was predicted to be high. Current velocities during that dive were indeed very high, to such an extent that the dive had to be aborted after several hours. Surprisingly, only a modest density community was found during that dive, suggesting that there is an upper limit to current velocities under which high-density communities form.

During each benthic community survey, the ROV descended onto the seafloor and then slowly moved up slope, documenting the biology and geology of the area. Onboard and shore-based scientists identified each encountered organism to the lowest possible taxon, as well as provided geological interpretations of the observed substrate. A total of 334 different types of animals were identified in the field from video surveys; these included cnidarians, sponges, echinoderms, arthropods, mollusks, tunicates, bryozoans, ctenophores, siphonophores, and fishes. Of these, the vast majority was only identified to genus or higher.

The most striking geological observation from the dives was the preservation of primary pillow lava morphology, with only minor mass wasting, despite the old ages of the rocks (10 to 28 Ma). The development of FeMn crusts on the rocks was extensive (>1 cm in some cases), as would be expected for this age, since FeMn crust growth rates are estimated at 2.5 mm per Ma in Hawaiian waters.

In addition to surveying the seafloor, the ship's dual-body ROV system was also used to conduct a series of midwater transects at two ROV dive locations: southeast of Pearl and Hermes Atoll (Dive 12) and northeast of Gardner Pinnacles (Dive 17). Midwater



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transects were conducted after seafloor surveys were completed and the ROV was ascending towards the surface. The objectives were to explore midwater habitats between 550 m and 1200 m in order to examine the potential prey field for deep-diving toothed whales, and to document other nekton and gelatinous megaplankton in this depth zone. Five to six 10-minute midwater transects were completed at each site, which recorded a variety of pelagic animals including jellyfishes, ctenophores, siphonophores, shrimps, copepods, fishes, and a squid (**Fig. 11**).

This cruise included a pilot sampling effort of biological and geological specimens. These first-ever collections by the *D2* ROV targeted rocks that were volcanic in origin and, therefore, have the potential to provide information on the age and chemical composition of the feature they were collected from. In contrast, biological specimen collections targeted potential new species or known species that were not previously recorded in the region.



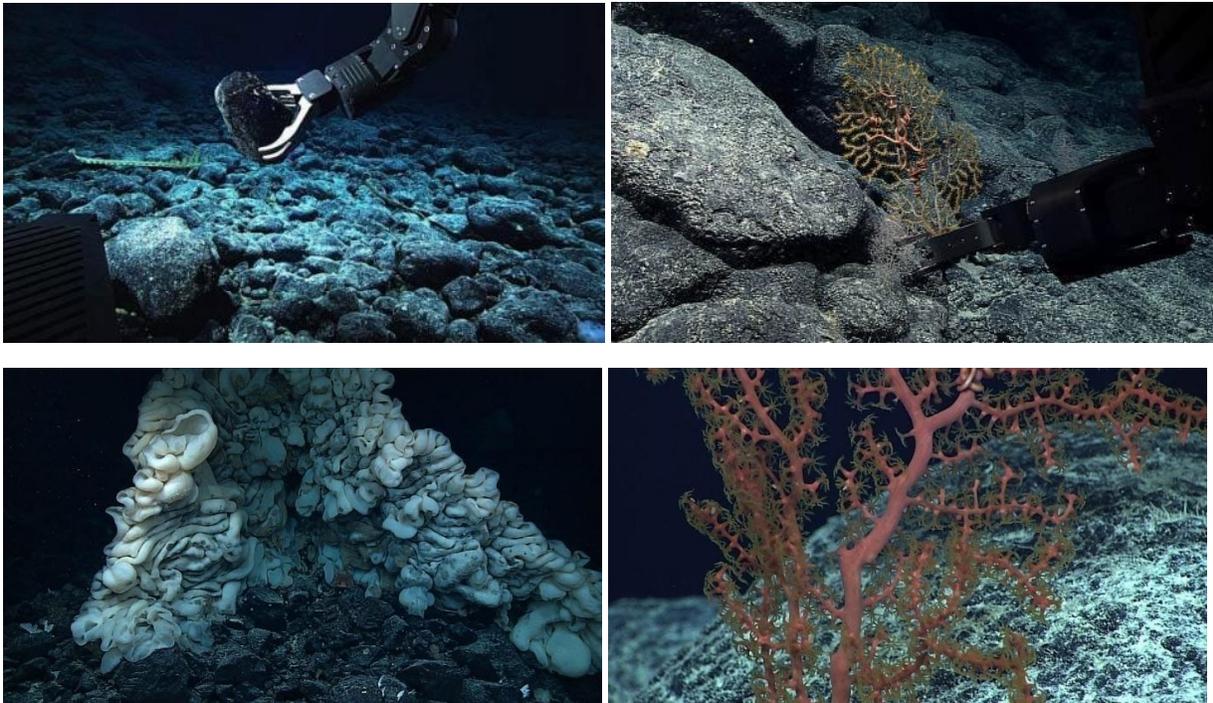
**Figure 11.** Left: A *Walvisteuthis youngorum* squid imaged during mid-water transects conducted at the end of ROV Dive 17. Right: Lobate ctenophore imaged during mid-water transects conducted at the end of ROV Dive 12.

A total of 96 samples were collected during the expedition, including 31 rocks and 65 biological specimens (**Fig. 12, Table 5, Table 6**). The rocks were all basalt with FeMn encrustations of varying thicknesses. The 61 biological specimens included 25 cnidarians (17 gorgonian corals, four black corals, one mushroom coral, one stylasterid coral, and two hydroids), 15 sponges (five demosponges and 10 glass sponges), eight echinoderms (two sea stars, two feather stars, and four brittle stars), 10 arthropods (four squat lobsters, two barnacles, two shrimps, and two amphipods), three polychaete worms, and one ctenophore. Among these were some particularly unusual specimens of both sponges and corals that will likely turn out to be new undescribed species. **Tables 5** and



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6 provide summary data for each rock and biological specimen collected during the cruise.



**Figure 12.** First sample ever collected by the *EX* (top left), a gorgonian coral with a brittle star (top right), a new species of *Lophocalyx* (bottom left) and a plexaurid gorgonian in the genus *Swiftia* (bottom right).

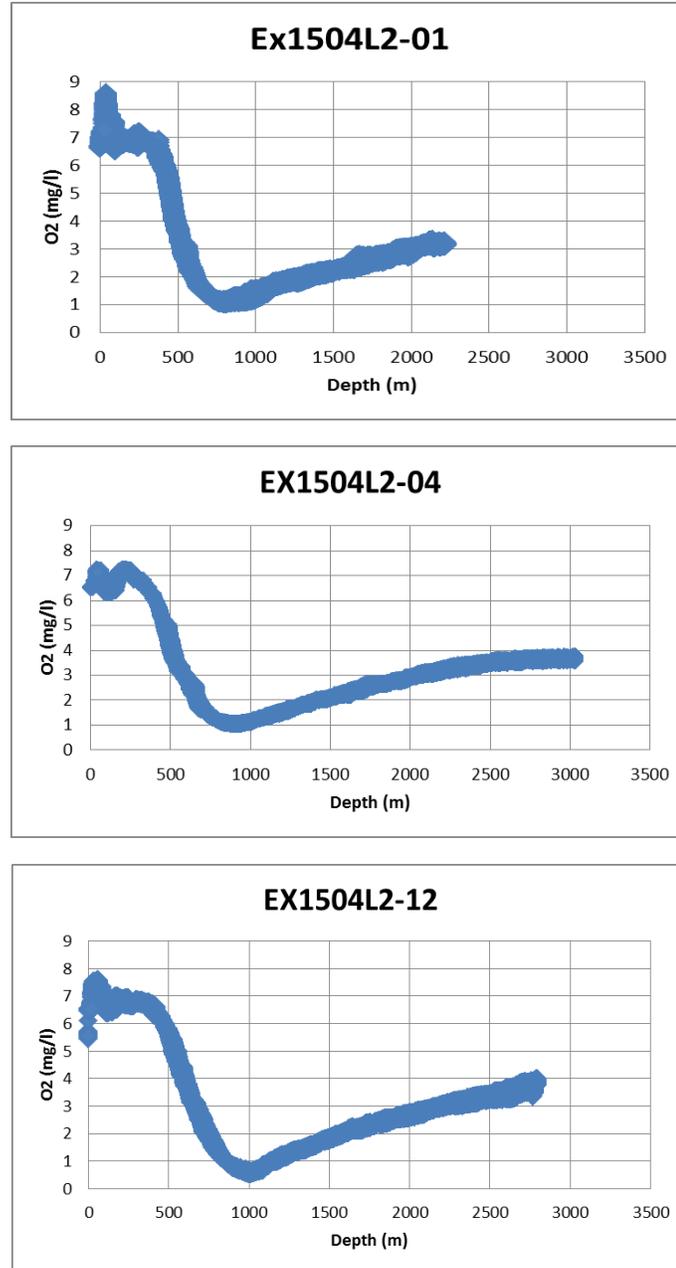
### 4.2.3. Environmental Findings

Temperature, salinity, and DO data from the *D2* ROV raw CTD data revealed a particularly interesting geographic pattern, with respect to the oxygen minimum depth.

**Fig. 13** shows the DO graphs for Dives 1, 4, and 12, which were conducted in the southern, middle, and northern sections of PMNM, respectively.



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**Figure 13.** DO (O<sub>2</sub>) data from ROV Dives 1 (top), 4 (middle), and 12 (bottom). Dive 1 took place at roughly latitude 23 N, Dive 4 at 25 N, and Dive 12 at 27.5 N. Oxygen minimum depths were 794 m, 901 m, and 1,015 m, respectively.



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These and the data from the other ROV dives revealed that the depth of the lowest oxygen values reached during the dives increased by 100 m for every two-degree increase in latitude.

## 4.2.4. Lists of Sample Collections

**Table 5: Rock Samples Collected During EX-15-04-L2**

Sample ID#	Current Identification	Lat	Long	Depth (m)	Archival Location
EX1504L2_20150802T223100_D2_DIVE01_SPEC01GEO	FeMn-crusted basalt	23.22	-163.52	1472	OSU
EX1504L2_20150803T011500_D2_DIVE01_SPEC02GEO	FeMn-crusted basalt	22.23	-163.52	1836	OSU
EX1504L2_20150804T001600_D2_DIVE02_SPEC03GEO	FeMn-crusted basalt	24.43	-166.09	2407	OSU
EX1504L2_20150804T022800_D2_DIVE02_SPEC04GEO	FeMn-crusted basalt	24.43	-166.09	2243	OSU
EX1504L2_20150804T223900_D2_DIVE03_SPEC03GEO	FeMn-crusted basalt	25.63	-167.24	2050	OSU
EX1504L2_20150805T202400_D2_DIVE04_SPEC01GEO	FeMn-crusted basalt	25.16	-169.88	3032	OSU
EX1504L2_20150806T000100_D2_DIVE04_SPEC02GEO	FeMn-crusted basalt	25.16	-169.88	6273	OSU
EX1504L2_20150806T230800_D2_DIVE05_SPEC01GEO	FeMn-crusted basalt	24.58	-169.91	4698	OSU
EX1504L2_20150807T220700_D2_DIVE06_SPEC01GEO	FeMn-crusted basalt	25.08	-172.49	1965	OSU
EX1504L2_20150807T232000_D2_DIVE06_SPEC03GEO	FeMn-crusted basalt	25.08	-172.49	1896	OSU



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EX1504L2_20150808T210400_D2 _DIVE07_SPEC01GEO	FeMn-crusted basalt	25.51	-173.52	2083	OSU
EX1504L2_20150808T231600_D2 _DIVE07_SPEC04GEO	FeMn-crusted basalt	25.51	-173.52	2001	OSU
EX1504L2_20150810T002400_D2 _DIVE08_SPEC02GEO	FeMn-crusted basalt	26.83	-175.61	1164	OSU
EX1504L2_20150810T012900_D2 _DIVE08_SPEC03GEO	FeMn-crusted basalt	26.83	-175.61	1169	OSU
EX1504L2_20150810T194000_D2 _DIVE09_SPEC01GEO	FeMn-crusted basalt	27.14	-176.23	2278	OSU
EX1504L2_20150810T220800_D2 _DIVE09_SPEC02GEO	FeMn-crusted basalt	27.14	-176.23	2251	OSU
EX1504L2_20150810T233600_D2 _DIVE09_SPEC04GEO	FeMn-crusted basalt	27.14	-176.23	2170	OSU
EX1504L2_20150811T215800_D2 _DIVE10_SPEC01GEO	FeMn-crusted basalt	26.82	-176.31	1955	OSU
EX1504L2_20150812T205000_D2 _DIVE11_SPEC01GEO	FeMn-crusted basalt	27.13	-175.57	2144	OSU
EX1504L2_20150812T221200_D2 _DIVE11_SPEC02GEO	FeMn-crusted basalt	27.13	-175.57	2120	OSU
EX1504L2_20150813T211200_D2 _DIVE12_SPEC02GEO	FeMn-crusted basalt	27.52	-175.46	2794	OSU
EX1504L2_20150814T004400_D2 _DIVE12_SPEC04GEO	FeMn-crusted basalt	27.52	-175.46	2780	OSU
EX1504L2_20150814T202100_D2 _DIVE13_SPEC01GEO	FeMn-crusted basalt	27.85	-175.16	2286	OSU
EX1504L2_20150814T220800_D2 _DIVE13_SPEC03GEO	FeMn-crusted basalt	27.85	-175.17	2161	OSU



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EX1504L2_20150815T205000_D2_DIVE14_SPEC01GEO	FeMn-crusted basalt	26.20	-173.33	1587	OSU
EX1504L2_20150816T002100_D2_DIVE14_SPEC04GEO	FeMn-crusted basalt	26.20	-173.33	1528	OSU
EX1504L2_20150816T193400_D2_DIVE15_SPEC01GEO	FeMn-crusted basalt	25.81	-171.10	1741	OSU
EX1504L2_20150816T230400_D2_DIVE15_SPEC03GEO	FeMn-crusted basalt	25.81	-171.09	1645	OSU
EX1504L2_20150818T193800_D2_DIVE17_SPEC01GEO	FeMn-crusted basalt	25.88	-167.78	2082	OSU
EX1504L2_20150818T234500_D2_DIVE17_SPEC03GEO	FeMn-crusted basalt	25.88	-167.78	2041	OSU
EX1504L2_20150820T213700_D2_DIVE18_SPEC01GEO	FeMn-crusted basalt	23.18	-162.46	1515	OSU

**Table 6: Biological Specimens Collected During EX-15-04-L2**

Sample ID#	Initial Identification	Lat	Long	Depth (m)	Archival Location
EX1504L2_20150803T220700_D2_DIVE02_SPEC01BIO	<i>Pleurogorgia militaris?</i>	24.43528	-166.09497	2452	NMNH,B M,OGL
EX1504L2_20150803T220700_D2_DIVE02_SPEC01BIO_C01	Scalpellidae	24.43528	-166.09497	2452	USNM
EX1504L2_20150803T225100_D2_DIVE02_SPEC02BIO	<i>Parantipathes</i> sp.	24.43493	-166.09478	2464	USNM,B M,OGL



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EX1504L2_20150804T2033 00_D2_DIVE03_SPEC01BIO	Cladorhizidae	25.6264	-167.239	2153	USNM, OGL
EX1504L2_20150804T2204 00_D2_DIVE03_SPEC02BIO	<i>Heteropathes pacifica</i>	25.62658	-167.241	2128	NMNH, B M, OGL
EX1504L2_20150804T2328 00_D2_DIVE03_SPEC04BIO	<i>Jasonisis</i> sp.	25.62617	-167.241	1981	USNM, B M, OGL
EX1504L2_20150805T0040 00_D2_DIVE04_SPEC03BIO_C01	Chirostylidae	25.16483	-169.877	2654	USNM
EX1504L2_20150805T0143 00_D2_DIVE04_SPEC04BIO_C01	<i>Sarametra triserialis</i>	25.16462	-169.877	2676	USNM, OGL
EX1504L2_20150805T0143 00_D2_DIVE04_SPEC04BIO_C02	Scalpellidae	25.16462	-169.877	2676	USNM
EX1504L2_20150806T0040 00_D2_DIVE04_SPEC03BIO	<i>Chrysogorgia flavescens</i>	25.16483	-169.877	2654	USNM, OGL
EX1504L2_20150806T0143 00_D2_DIVE04_SPEC04BIO	Isididae unbranched	25.16462	-169.877	2676	USNM, OGL
EX1504L2_20150806T2323 00_D2_DIVE05_SPEC02BIO	<i>Hyalostylus</i> sp?	24.58477	-169.914	4691	NMNH, B M, OGL
EX1504L2_20150807T2207 00_D2_DIVE06_SPEC01GEO_C01	Hydrozoa	25.08195	-172.4892	1965	USNM, OGL
EX1504L2_20150807T2311 00_D2_DIVE06_SPEC02BIO	<i>Iridogorgia</i> sp.	25.08257	-172.4904	1896	NMNH, B M, OGL
EX1504L2_20150807T2320 00_D2_DIVE06_SPEC03GEO_C01	Polychaeta	25.08257	-172.4904	1896	USNM



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EX1504L2_20150807T2320 00_D2_DIVE06_SPEC03GEO _C02	Aulocalycoida - Hexactinosida	25.08257	-172.4904	1896	USNM
EX1504L2_20150808T2104 00_D2_DIVE07_SPEC01GEO _C01	Cladorhizidae	25.50939	-173.522	2083	USNM
EX1504L2_20150808T2204 00_D2_DIVE07_SPEC02BIO	<i>Hemicorallium</i> sp.	25.50994	-173.522	2078	USNM,OG L
EX1504L2_20150808T2254 00_D2_DIVE07_SPEC03BIO	<i>Hemicorallium</i> sp.	25.51069	-173.522	2002	USNM,OG L
EX1504L2_20150808T2254 00_D2_DIVE07_SPEC03BIO _C01	Ophiuroidea	25.51069	-173.522	2002	USNM,OG L
EX1504L2_20150808T2316 00_D2_DIVE07_SPEC04GEO _C01	Hydrozoa	25.51066	-173.522	2001	USNM
EX1504L2_20150809T0129 00_D2_DIVE08_SPEC03GEO _C01	Brisingiidae	26.82864	-175.6075	1169	USNM
EX1504L2_20150809T2337 00_D2_DIVE08_SPEC01BIO	Antipatharia	26.82659	-175.60753	1229	USNM,B M,OGL
EX1504L2_20150809T2337 00_D2_DIVE08_SPEC01BIO _C01	Mysidae	26.82659	-175.60753	1229	USNM,OG L
EX1504L2_20150809T2337 00_D2_DIVE08_SPEC01BIO _S02	<i>Farrea</i> nr. <i>occa</i>	26.82659	-175.60753	1229	BM,OGL
EX1504L2_20150809T2337 00_D2_DIVE08_SPEC01BIO _C02	Squat lobster	26.82659	-175.60753	1229	USNM



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EX1504L2_20150809T2337 00_D2_DIVE08_SPEC01BIO _C03	Polychaeta	26.82659	-175.60753	1229	USNM
EX1504L2_20150810T0308 00_D2_DIVE08_SPEC04BIO	Comatulida	26.83049	-175.60756	1103	USNM,OG L
EX1504L2_20150810T2230 00_D2_DIVE09_SPEC03BIO	Lophocalyx sp.?	27.14139	-176.22912	2247	USNM,B M,OGL
EX1504L2_20150811T0058 00_D2_DIVE09_SPEC05BIO	Lanuginellinae	27.14316	-176.22617	2104	USNM,B M,OGL
EX1504L2_20150811T0058 00_D2_DIVE09_SPEC05BIO _C01	Shrimp	27.14316	-176.22617	2104	USNM
EX1504L2_20150811T2239 00_D2_DIVE10_SPEC02BIO	<i>Chrysogorgia averta</i>	26.81832	-176.31509	1939	USNM,OG L
EX1504L2_20150811T2239 00_D2_DIVE10_SPEC02BIO _C01	Squat lobster	26.81832	-176.31509	1939	USNM
EX1504L2_20150811T2239 00_D2_DIVE10_SPEC02BIO _C02	Amphipoda	26.81832	-176.31509	1939	USNM
EX1504L2_20150811T2239 00_D2_DIVE10_SPEC02BIO _S01	<i>Chrysogorgia averta</i>	26.81832	-176.31509	1939	USNM,OG L
EX1504L2_20150811T2350 00_D2_DIVE10_SPEC03BIO	<i>Lefroyella</i> sp. (tubes)	26.81893	-176.3159	1880	USNM,B M,OGL
EX1504L2_20150811T2350 00_D2_DIVE10_SPEC03BIO _S01	<i>Lefroyella</i> sp. (tubes)	26.81893	-176.3159	1880	USNM,B M,OGL



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EX1504L2_20150812T0107 00_D2_DIVE10_SPEC04BIO	Plexauridae	26.81924	-176.31653	1848	USNM,B M,OGL
EX1504L2_20150812T0107 00_D2_DIVE10_SPEC04BIO _C01	Ophiuroidea	26.81924	-176.31653	1848	USNM,OG L
EX1504L2_20150812T0107 00_D2_DIVE10_SPEC04BIO _C02	Amphipoda	26.81924	-176.31653	1848	USNM
EX1504L2_20150812T2233 00_D2_DIVE11_SPEC03BIO	<i>Crypthelia</i> sp.	27.1308	-175.57091	2116	USNM,OG L
EX1504L2_20150813T0020 00_D2_DIVE11_SPEC04BIO	<i>Lefroyella</i> sp. (vase)	27.12873	-175.5703	2112	USNM,B M,OGL
EX1504L2_20150813T0020 00_D2_DIVE11_SPEC04BIO _S01	<i>Lefroyella</i> sp. (vase)	27.12873	-175.5703	2112	USNM,B M,OGL
EX1504L2_20150813T2112 00_D2_DIVE12_SPEC02GEO _C01	Cladorhizidae	27.51692	-175.45969	2794	USNM
EX1504L2_20150813T2212 00_D2_DIVE12_SPEC03BIO	<i>Keratoisis</i> sp.	27.51735	-175.46051	2775	USNM,B M,OGL
EX1504L2_20150814T0044 00_D2_DIVE12_SPEC04GEO _C01	Cladorhizidae	27.51903	-175.46152	2780	USNM,B M
EX1504L2_20150814T0135 00_D2_DIVE12_SPEC05BIO _C01	Ophiuroidea				USNM,OG L
EX1504L2_20150814T2157 00_D2_DIVE13_SPEC02BIO	<i>Keratoisis</i> sp.	27.85476	-175.16733	2149	USNM,B M,OGL



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EX1504L2_20150814T223800_D2_DIVE13_SPEC04BIO	<i>Pythonaster</i> sp.	27.85466	-175.16802	2160	USNM,OGL
EX1504L2_20150814T223800_D2_DIVE13_SPEC04BIO_C01	<i>Caulophacus (oxydiscus)</i> sp.	27.85466	-175.16802	2160	BM,OGL
EX1504L2_20150815T210600_D2_DIVE14_SPEC02BIO	<i>Narella</i> sp. unbranched	26.20098	-173.32551	1587	USNM,OGL
EX1504L2_20150815T210600_D2_DIVE14_SPEC02BIO_C01	Ophiuroidea	26.20098	-173.32551	1587	USNM,OGL
EX1504L2_20150815T232100_D2_DIVE14_SPEC03BIO	<i>Parantipathes</i> sp.	26.19829	-173.32632	1535	USNM,BM,OGL
EX1504L2_20150815T232100_D2_DIVE14_SPEC03BIO_C01	Squat lobster	26.19829	-173.32632	1535	USNM
EX1504L2_20150816T202100_D2_DIVE15_SPEC02BIO	Plexauridae	25.81237	-171.09771	1720	USNM,OGL
EX1504L2_20150817T012800_D2_DIVE15_SPEC04BIO	<i>Acanthogorgia</i> sp.	25.81419	-171.08942	1554	USNM,OGL
EX1504L2_20150817T210100_D2_DIVE16_SPEC01BIO	<i>Semperella</i> sp.	25.63979	-168.851	1464	USNM,BM,OGL
EX1504L2_20150817T210100_D2_DIVE16_SPEC01BIO_C01	Platyctenidae	25.63979	-168.851	1464	USNM
EX1504L2_20150818T013700_D2_DIVE16_SPEC02BIO	<i>Eknomisis</i> sp.	25.64543	-168.844	1412	NMNH,BM,OGL
EX1504L2_20150818T194200_D2_DIVE17_SPEC02BIO	<i>Chonelasma</i> sp.	25.88028	-167.78132	2082	USNM,BM,OGL



EX1504L2_20150819T003400_D2_DIVE17_SPEC04BIO	<i>Hemicorallium</i> sp.	25.88589	-167.78036	2022	USNM,OGL
EX1504L2_20150819T013700_D2_DIVE17_SPEC05BIO	<i>Stelodoryx</i> sp.	25.8875	-167.78037	1980	USNM,BM,OGL
EX1504L2_20150819T014500_D2_DIVE17_SPEC06BIO	<i>Pseudoantho mastus</i> sp.	25.88749	-167.78036	1980	USNM,OGL
EX1504L2_20150819T014500_D2_DIVE17_SPEC06BIO_C01	Polychaeta	25.88749	-167.78036	1980	USNM
EX1504L2_20150819T020000_D2_DIVE17_SPEC07BIO	<i>Keratoisis</i> sp.	25.88749	-167.78036	1980	USNM,BM,OGL

## 5. Data Deposition and Archival

The EX-15-04-L2 Data Management Plan can be found in Appendix B of the EX-15-04-L2 Project Instructions, available at:

[ftp://ftp.library.noaa.gov/oedv.lib/Okeanos Explorer 2015\\_EX1504/doc/Leg\\_2/EX1504L2\\_cruise\\_plan.pdf](ftp://ftp.library.noaa.gov/oedv.lib/Okeanos_Explorer_2015_EX1504/doc/Leg_2/EX1504L2_cruise_plan.pdf) (DOI: 10.7289/V58K773B). The NOAA Ship *Okeanos Explorer* data types and product list can be found in Appendix C.

### 5.1 OER Data Discoverability Tools

All data collected by NOAA Ship *Okeanos Explorer* are archived and publically available within 90 days of the end of each cruise via NCEI online archives. Data can be accessed via the following websites:

- OER Digital Atlas at <https://www.ncei.noaa.gov/maps/oer-digital-atlas/mapsOE.htm> (Last accessed June 2020)
- OER ROV Data Archives at <https://service.ncddc.noaa.gov/rdn/oer-rov-cruises/ex1504l2> (Last accessed June 2020)



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Products created during the cruise, including the ship track, shaded bathymetry, dive locations and tracks, specimen collection data and images, ships meteorological and oceanographic sensor data, and status reports can be viewed on the interactive *Okeanos Explorer* Atlas.

Additional data requests are handled through the NOAA Ocean Exploration and Research Program Data Access Request Form which can be found here:

[https://docs.google.com/a/noaa.gov/forms/d/e/1FAIpQLSdBLvbtStVhGrDO3Ugn\\_sNJpgR1Yy-e-DaUU3TIqGjg07ITNg/viewform?formkey=dHAycC1MYndJb0hTdGRaYXAzVTVBdWc6MA&formEmail=true](https://docs.google.com/a/noaa.gov/forms/d/e/1FAIpQLSdBLvbtStVhGrDO3Ugn_sNJpgR1Yy-e-DaUU3TIqGjg07ITNg/viewform?formkey=dHAycC1MYndJb0hTdGRaYXAzVTVBdWc6MA&formEmail=true)

## 5.2 Sonar Data

Sonar data collected onboard NOAA Ship *Okeanos Explorer* undergoes quality assurance/quality control (QA/QC) after a cruise and is then made publicly available through the OER Data Discoverability Tools, the NCEI, and the following websites (last accessed June 2020):

- NCEI Interactive Bathymetry Data Viewer at:  
<https://maps.ngdc.noaa.gov/viewers/bathymetry/>
- NCEI Interactive Water Column Sonar Data Viewer at:  
[https://www.ngdc.noaa.gov/maps/water\\_column\\_sonar/index.html](https://www.ngdc.noaa.gov/maps/water_column_sonar/index.html)
- NCEI map tool with tracklines showing all publicly available geophysical surveys:  
<https://maps.ngdc.noaa.gov/viewers/geophysics/>

## 5.2 Physical Samples

Biological samples collected during *EX* expeditions are archived in the collections of the USNM, Smithsonian Institution. Here, they are catalogued, curated, and made publically available. Biological samples of invertebrate organisms are archived in the Invertebrate Zoology Collections (<https://naturalhistory.si.edu/research/invertebrate-zoology>) and information on how to request access to these samples can be found here:



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<https://naturalhistory.si.edu/research/invertebrate-zoology/collections-access/specimen-loans>. Biological samples of fishes are archived in the Division of Fishes of the Vertebrate Zoology Collections (<https://naturalhistory.si.edu/research/vertebrate-zoology/fishes>), and information on how to request access to these samples can be found here: <https://naturalhistory.si.edu/research/vertebrate-zoology/fishes/collections-access/specimen-loans>.

Selected coral and sponge specimens were split; one aliquot was sent to the Bernice Pauahi Bishop Museum (BM) (<https://www.bishopmuseum.org/collections-3/invertebrate-zoology/>) and another sent to the USNM. If it had been determined that splitting would be too destructive to a particular specimen, it was provided to the USNM intact in order to provide public access to as many researchers as possible.

An additional small tissue sample for genetic analysis was taken of corals, sponges, and all other specimens when doing so would not effectively destroy the specimen. This tissue sample was preserved for later genomic DNA extraction at the OGL Center at Northeastern University (<https://www.northeastern.edu/ogl/>). Information on how to request access to these results and any remaining DNA samples can be found at: <https://www.northeastern.edu/ogl/>.

All geological samples collected during EX expeditions were sent to the MGR at OSU (<http://osu-mgr.org/noaa-ex/>) where they were described from a petrology perspective (e.g. mineral content, texture, alteration, rock type), photographed, and made publicly accessible. The repository provides photographs (including microphotographs) and online metadata information about each geological specimen. Information on how to request access to these geological samples can be found here: <http://osu-mgr.org/request-samples/>.

## 6. Additional Information

### 6.1 Permits/Clearances

EX-15-04-L2 was conducted under the Scientific Research Permit PMNM-2015-018 (Appendix D) issued to ROV expedition coordinator and permit PMNM-2015-025 (Appendix E) issued to EX Commanding officer to conduct work in the Papahānaumokuākea Marine



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National Monument (PMNM). The permit was issued by the Co-Trustees of the PMNM Board effective July 1, 2015 and expiring June 30, 2016.

In order to support or conduct Marine Scientific Research within the U.S. exclusive economic zone (EEZ), work funded, authorized, and/or conducted by NOAA must be compliant with the National Environmental Policy Act (NEPA). The NOAA Administrative Order (NAO) 216-6A Companion Manual (<https://www.nepa.noaa.gov/docs/NOAA-NAO-216-6A-Companion-Manual-03012018.pdf>)

describes NOAA's specific obligations with regard to NEPA compliance. Among these is the need to review all NOAA-supported projects with respect to their environmental consequences. In compliance with NAO 216-6 and NEPA, a memorandum describing the project's scientific sensors' possible effects on the environment has been submitted for the project. As expected with ocean research with limited time or presence in the marine environment, the project has been determined to not have the potential to result in any lasting changes to the environment. As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this is a research project of limited size or magnitude or with only short-term effects on the environment and for which any cumulative effects are negligible, and, as such, the project is categorically excluded from the need to prepare a full-scale NEPA environmental assessment. The categorical exclusion met the requirements of NAO 216-6 and NEPA, and authorizes the Marine Scientific Research conducted for the project (Appendix F).

OER also completed an informal consultation with NMFS under Section 7 of the Endangered Species Act (ESA) of 1973 that addressed the potential impacts of project activities to ESA-listed species and critical habitat within the project operating area. A letter of concurrence (Appendix G) was received from NMFS on July 7, 2015, concurring with OER's determination that EX-15-04-L2 cruise activities would not likely have an adverse effect on ESA-listed marine species, and would have insignificant effects on designated or proposed critical habitat.

## 7. References

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## 8. Appendices

### Appendix A: NASA Aerosol Survey of Opportunity

#### NASA Maritime Aerosols Network Survey of Opportunity

Survey or Project Name  
Maritime Aerosol Network

Lead POC or Principle Investigator (PI & Affiliation)  
POC: Dr. Alexander Smirnov



## Ocean Exploration and Research

### Supporting Team Members Ashore

### Supporting Team Members Aboard (if required)

#### Activities Description(s) (Include goals, objectives and tasks)

The Maritime Aerosol Network (MAN) component of the Aerosol Robotic Network (AERONET) provides ship-borne aerosol optical depth measurements from the Microtops II sun photometers. These data provide an alternative to observations from islands as well as establish validation points for satellite and aerosol transport models. Since 2004, these instruments have been deployed periodically on ships of opportunity and research vessels to monitor aerosol properties over the world ocean.

During the cruise, the marine aerosol layer observations were collected for the NASA MAN research effort. Observations were made by mission personnel (as time and weather allowed) with a sun photometer instrument provided by the NASA MAN program. Resulting data were delivered to the NASA MAN primary investigator, Dr. Alexander Smirnov, by the expedition coordinator. All collected data were archived and are publicly available at:

[http://aeronet.gsfc.nasa.gov/new\\_web/maritime\\_aerosol\\_network.html](http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html)

Equipment resides on the ship and is stewarded by the Expedition Coordinator.

### Appendix B: ROV Dive Summaries

To view and download the full Dive Summaries and the accompanying data for each dive (Fig. 14), please visit: <https://www.ncei.noaa.gov/waf/oceanos-rov-cruises/ex150412/> (Last accessed June 2020).



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Figure 14. A screenshot of the EX-15-04-L2 Dive Summaries overview page.



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## Appendix C: Available Data and Products

<b>PRODUCTS AVAILABLE DURING A CRUISE:</b> <i>A variety of data and products will be collected and/or developed aboard Okeanos Explorer (EX) and at shore-side Exploration Command Centers (ECCs) during the EX 2017 Field Season. Operational products and datasets will be made available to participants during and after the cruise, and can be accessed from several internet-based tools. Below is a summary of products anticipated to be developed for operational uses, product descriptions and information on where to go to access these products during a cruise.</i>						
Product	Description	Format	Developer	Developer Location	Access Location	Access Level
<b>OPERATIONS</b>						
<b>Daily Science Team Emails</b>	Brief summary of today's operations and plans and participation info for next two days.	Emails	Science Leads	Ship	Email	Participants/Listserv
<b>Plan of the Day</b>	Plan of the day detailing ship operations	DOCX	Operations Officer	Ship	FTP site / Cruise Data File Server	Participants
<b>SITREPs</b>	Internal Document; Daily status report detailing EX operations	DOCX, PDF	Expedition Coordinator	Ship	FTP Site; Email	OER staff
<b>Mapping</b>						
<b>Raw EM302 Data</b>	Selected full resolution bathymetry and bottom backscatter data. Water column backscatter where appropriate and on a limited basis.	.all, .wcd	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants



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<b>EK60 Single Beam Data</b>	Raw water column data. Where appropriate, a processed level 2 image.	.raw, Fledermaus .sd, Image (.jpeg, .TIFF)	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants
<b>Sub-Bottom Profiler Data</b>	Raw data. Where appropriate, a processed geo-referenced vertical curtain.	.seg-y, .keb, .kea, GeoTIFF, .sd.	Mapping team	Ship/Shore	FTP site / Cruise Data File Server	Participants
<b>Daily mapping progress bathymetry</b>	Site-specific or cumulative daily bathymetry	GeoTIFF; Fledermaus .sd; Google Earth .kmz, ASCII text file, Arc Grid .asc	Mapping team	Ship	FTP site / Cruise Data File Server	Participants
<b>Multibeam backscatter data</b>	Where appropriate, site specific backscatter data (seafloor / water column backscatter as needed)	GeoTIFF, .sd, Tiff	Mapping team	Ship	FTP site / Cruise Data File Server	Participants
<b>Science Operations Products</b>						
<b>ROV Dive Planning Form</b>	Planning form detailing desired ROV Ops including waypoints	DOCX, PDF	Science & ROV Team	Ship	Email; FTP site /Cruise Data File Server	Participants
<b>ROV Dive Summary Form</b>	Summary detailing completed ROV dive, summarizing observations,	DOCX, PDF	Science & ROV Team	Ship	FTP site / Cruise Data File Server	Participants



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	sample collections and including summary maps					
<b>ROV Tracklines</b>	File containing XYZ + T (1 min avg.) data of the ROV during a dive.	.csv table, KML	ROV Team; Script	Ship	FTP site / Cruise Data File Server	Participants
<b>Hypack Targets</b>	File containing the targets dropped during a dive	KML	ROV Team; Script	Ship	FTP site / Cruise Data File Server	Participants
<b>SeaScribe Annotation Log</b>	Scientific observation log noting fauna, geology and other observations from an ROV dive	CSV	Expedition science participants contribute; SeaScribe server auto-generates	Geographically Distributed	FTP site / Cruise Data File Server	Participants

<b>Chat Log</b>	Literally a group chat room with UTC time-coded and stamped observations that are saved and output as .txt files, and as excel files with associated lat, long, and depth for each entry.	TXT, XLSX	Expedition Science Participants contribute; Automated server generates	Geographically Distributed	FTP site / Cruise Data File Server	Participants
<b>Datasets</b>	Raw oceanographic data, SCS, CTD, DO, LSS, ORP, etc.	various	Automated process; STs	Ship	FTP site / Cruise Data File Server	Participants



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<b>CTD Rosette Summary Form</b>	Summary detailing completed ROV dive, summarizing observations, sample collections and including summary maps	DOCX	Science Team	Ship	FTP site / Cruise Data File Server	Participants
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Imagery						
<b>Raw Video Clips – Low Res</b>	Video clips from ROV dives, onboard cameras.	.mov (H.264 at 1.5 MB at 640x320)	Video team	Ship	FTP site / Cruise Data File Server	Participants, Web Coordinator and Science Participants
<b>Cruise Highlight Video</b>	OPTIONAL: video highlighting OER mission	.mov HR & LR	Video Team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Public
<b>Daily Highlight Videos</b>	Edited & Scored video of best clips from a specific dive (one per dive)	.mov HR & LR	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Public
<b>Custom Video Products</b>	OPTIONAL: One-off products for the OER website and outreach (Timelapses, "Sea Poke" video, etc)	.mov HR & LR	OER Program Personnel	Shore	FTP site / Cruise Data File Server (Low Res Only); OceanExplorer website	Participants
<b>Highlight Imagery</b>	HD Screengrabs; best 10-15 per dive; Edited for sharing online	Color corrected .jpg	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Participants



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<b>Still Images</b>	frame grabs from underwater video which map to the video clips	JPG; TIFF	Video team	Ship	FTP site / Cruise Data File Server (Low Res Only)	Participants
<b>News Articles</b>	Provides more context or info on expedition events	Online	Various	Various	Ocean Explorer Website	Participants/ Public
<b>Sampling</b>						
<b>Daily Sample Report</b>	Daily output from SODA that includes information about every sample, lab preparation, and identifies associated images and video	.pdf	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
<b>Daily List of Sampling Associated Images and Video</b>	List of all samples and associated video. This list is used to build the folders of in situ video and stills. Output from the database?	.txt	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
<b>In situ images (via symlinks)</b>	Symbolic links that create a folder of all images associated with a particular sample	JPG via Symlinks	Images - Video team; Identification of Images - Sample Data Manager; Symlinks-Data Manager	Ship	FTP site / Cruise Data File Server	Participants
<b>Video of collection (via symlinks)</b>	Symbolic links that create a folder of all videos associated with a particular sample	.mov via Symlinks	Identification of videos - Sample Data Manager; Symlinks-Data Manager	Ship	FTP site / Cruise Data File Server	Participants



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<b>Lab images</b>	Images of samples taken with a color pallet and sample label	RAW, JPG, CR2	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
<b>Microscope images</b>	Images taken using a Caltex LX- 100 Series Digital Microscope (when applicable)	JPG	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
<b>Microscope video</b>	Video taken using a Caltex LX- 100 Series Digital Microscope (when applicable)	MP4	Sample Data Manager	Ship	FTP site / Cruise Data File Server	Participants
<b>Records in ROV Dive Summary Form</b>	Tables located in the dive summary report that includes summary collection information, field ID, preparation, and any relevant notes about the specimen	.docx	Sample Data Manager	Ship	FTP site / Cruise Data File Server (Once Final)	Participants
<b>Final copy of cruise SODA (database)</b>	Microsoft Access database used during sampling operations to document the metadata of each biological or geological sample collected during a dive	Microsoft Access 2013 database (.accdb)	Sample Data Manager	Ship	FTP site / Cruise Data File Server (at conclusion of the cruise)	Participants



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<b>Final Sampling Table</b>	Table of all samples collected, associated data, preparations, planned archival locations, and names of associated imagery	.xls	Sample Data Manager	Ship	FTP site / Cruise Data File Server (at conclusion of the cruise)	Participants
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## PRODUCTS AVAILABLE AFTER A CRUISE

The following is a list and descriptions of quality assured products and data to be developed and made available after the cruise. Availability timing depends on the level of processing required. All data and products listed below are available for direct access from the OER Digital Atlas / Data Access tab. Documents, data and information are added to the Digital Atlas as they are processed and become available. If you cannot find the data you are looking for, please submit a data request form for assistance from the OER data management team.

Product	Description	Format	Developer	Developer Location	Access Location	Access Level
<b>OPERATIONS</b>						
<b>Cruise Report</b>	Cruise report summarizing the operations and results of the cruise	DOCX, PDF	Expedition Coordinator (with input from team leads)	Shore	OER Digital Atlas; NCEI	Participants
<b>Initial Expedition Summary</b>	Initial, first look at the results of the cruise	DOCX	Science, Expedition Coordinator	Ship	Email	Partners
<b>Expedition Summary</b>	Summary of major initial expedition findings	PDF	Engagement Team	Shore	OceanExplorer Website	Public



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<b>Expedition Infographic</b>	Summary of expedition statistics	PDF	Engagement Team	Shore	OceanExplorer Website	Public
<b>Science Operations Products</b>						
<b>ROV Dive Summary Forms</b>	Summary of dive with operational info, site description and overview of observations	DOCX, PDF	ROV Team, Science Lead	Ship	OER Digital Atlas; NCEI	Participants
<b>CTD Summary Forms</b>	Summary of CTD cast results; detail sample collection	DOCX, PDF	Science Team	Ship and Shore	OER Digital Atlas; NCEI	Participants
<b>Water Column Profile Data</b>	Water Column profiles of sound velocity, XBT, and CTD data collected for mapping.	.asvp, .txt, .cnv	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
<b>Sampling</b>						



# Ocean Exploration and Research

<b>Final Sample Database</b>	Microsoft Access database used during sampling operations to document the metadata of each biological or geological sample collected during a dive	Microsoft Access 2013 database (.accdb)	Sample Data Manager	Ship	OER Digital Atlas; NCEI	Public
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<b>Final Sample Summary Table</b>	Table of all samples collected, associated data, preparations, planned archival locations, and names of associated imagery	.xls	Sample Data Manager	Ship	OER Digital Atlas; NCEI	Public
<b>Sample Layer in Okeanos Explorer Atlas</b>	Geospatial layer in the Okeanos Explorer Digital Atlas that associates the locations of samples with digital data collected	Okeanos Explorer Atlas layer	OER Data Manager	NCEI	Okeanos Explorer Atlas; NCEI	Public



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<b>Biologic Samples</b>	Biologic samples collected during the cruise are made available through the Smithsonian	Specimen	CAPSTONE Science Adviser; Smithsonian	University of Hawaii	<a href="#">Invertebrate Zoology Collection</a>	Public
<b>Ocean Genome Legacy Samples</b>	Biologic samples preserved for genetic analysis for the Ocean Genome Legacy Project collected during the cruise are made available through the Northeastern's OGL Project.	Specimen	CAPSTONE Science Adviser; OGL at Northeastern	University of Hawaii	<a href="#">Ocean Genome Legacy Center</a>	Public
<b>Geologic Samples</b>	Geologic samples collected during the cruise are made available through the Smithsonian	Specimen	CAPSTONE Science Adviser, Oregon State University	University of Hawaii	<a href="#">OSU Marine Geology Repository</a>	Public
<b>Mapping</b>						
<b>Expedition Summary Map</b>	Standard map showing bathymetry data, ROV dive sites, CTD casts and possibly XBTs	PDF	Mapping Team	Ship	OceanExplorer Website; OER Digital Atlas	



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<b>Mapping Data Processing Log</b>	Excel sheet of metadata describing mapping data files information, notes, processing checklist, and QC.	Excel Spreadsheet (.xlsx)	UNH (Mapping team)	UNH, Ship, Shore	OER Digital Atlas; NCEI	Public
<b>Level 0 EM302 Data</b>	Raw uncleaned multibeam sonar files.	Raw EM302 multibeam files (.all, .wcd)	UNH (Mapping team), SST	UNH, Ship	OER Digital Atlas; NCEI	Public
<b>Level 0 EK60 Data</b>	Raw EK60 split-beam sonar files.	.bot, .idx, .raw	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
<b>Level 0 Sub-Bottom Profiler Data</b>	Knudsen 3260 Sub- Bottom Profiler sonar data.	.sgy, .keb, .kea	UNH (Mapping Team)	UNH, Ship	OER Digital Atlas; NCEI	Public
<b>Level 1 EM302 Multibeam Data</b>	Edited & cleaned full resolution multibeam bathymetry data by line	.gsf	UNH (Mapping Team)	UNH, Ship	.gsf to NCEI, HDCS to NOAA OCS	Public



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<p><b>Level 2 EM 302 Multibeam Bathymetry and Bottom Backscatter Data</b></p>	<p>Cleaned and gridded bathymetry files at summary 25-100 meter resolution, backscatter mosaics (as available)</p>	<p>gridded data (ASCII .xyz), geotiff (.tif/.tiff or .tif), Fledermaus objects (.sd), Google Earth (.kmz), ArcGIS Grid (.asc), backscatter mosaic images (.tif)</p>	<p>UNH (Mapping team)</p>	<p>UNH, Ship</p>	<p>OER Digital Atlas; NCEI</p>	<p>Public</p>
<p><b>Level 2 EM302 Multibeam Data Coverage Polygons</b></p>	<p>Survey coverage shapefile used to calculate square km mapped and to show EX activities on the IOCM SeaSketch site.</p>	<p>ArcGIS shapefile (.shp)</p>	<p>UNH (Mapping team)</p>	<p>UNH</p>	<p>OER Digital Atlas; NCEI</p>	<p>Internal to NOAA</p>
<p><b>Mapping Data Report</b></p>	<p>Summary of Mapping operations and accomplishments  Given a DOI # and archived with data.</p>	<p>Doc and PDF</p>	<p>Expedition Mapping Lead</p>	<p>UNH, Shore</p>	<p>OER Digital Atlas; NCEI</p>	<p>Public</p>
<p><b>Imagery</b></p>						



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<b>Raw Video Clips– Full Res</b>	Video clips from ROV dives, onboard cameras.	.mov (ProRes 422 LT at 145 Mb @ 1920 x 1080)	Video team	Ship	By Request (use data request form)	TBD
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<b>Highlight Images</b>	"Best of" compilation of imagery from expedition (Ship and Shore)	JPG (with Excel document containing captions, credit & additional info)	Web Coordinator	Shore	NCEI; OE Website	Participants/ Public
<b>All Expedition Video</b>	All video streamed from the ship to shore will be captured aboard the ship and stewarded by NOAA.	digital	Ship	Shore (ISC)	By request (form) Archives	Public
<b>Low resolution video at SeaTube</b>	Deck to deck video, searchable with annotations, with associated environmental data	Digital	ONC / OER	ONC	Web based portal	Public: Viewing, searching Login protected: Creating /editing annotations



# Ocean Exploration and Research

## Appendix D: PMNM Permit - Science

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**PAPAHĀNAUMOKUĀKEA**  
**Marine National Monument**

JUL 01 2015

### RESEARCH PERMIT

**Permittee:**  
Ms. Kelley Elliott  
NOAA Office of Ocean Exploration and  
Research  
1315 East-West HWY, SSMC3 Room 10236  
Silver Spring, MD 20910

**Permit Number:** PMNM-2015-018  
**Effective Date:** July 1, 2015  
**Expiration Date:** June 30, 2016

**Project Title:** Bathymetric Mapping in Papahānaumokuākea Marine National Monument

This permit is issued for activities in accordance with Proclamation 8031 ("Proclamation") establishing Papahānaumokuākea Marine National Monument ("Monument") under the Antiquities Act of 1906, 16 USC §§ 431-433 ("Antiquities Act") and implementing regulations (50 CFR Part 404). All activities must be conducted in accordance with the Proclamation and the regulations (attached). No activity prohibited by the Proclamation or 50 CFR Part 404 is allowed except as specified below. Chapter 13-60.5, Hawaii Administrative Rules remains in effect for proposed activities in State waters.

Subject to the terms and conditions of this permit, the National Oceanic and Atmospheric Administration (NOAA), the State of Hawaii, and the U.S. Fish and Wildlife Service (collectively, the Co-Trustees) hereby authorize the permittee listed above to conduct research activities within the Monument. All activities are to be conducted in accordance with this permit. The permit application is incorporated into this permit and made a part hereof; provided, however, that if there are any conflicts between the permit application and the terms and conditions of this permit, the terms and conditions of this permit shall be controlling.

**PERMITTED ACTIVITY DESCRIPTIONS:**

The following activities are authorized by this permit:

1. The permittee and sixty-one (61) individuals from the following list are authorized to enter Papahānaumokuākea Marine National Monument ("PMNM" or "Monument") and conduct activities under this permit: one (1) Field Principal Investigator, Christopher Kelley; and sixty (60) research technicians: Brian Kennedy, John McDonough, Jeremy Potter, Elizabeth Lobecker, Derek Sowers, Lindsay McKenna, David Loyalvo, Brian Bringham, Brendan Reser, Jared Drewniak, Daniel Wagner, Michael Parke, Frank Parrish, and 47 TBDs. Permittee shall provide an updated Compliance Information Sheet prior to each entry into the Monument.

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2. Conducting mapping and deep sea characterization activities using the following instruments aboard NOAA Ship OKEANOS EXPLORER (vessel entrance and support operations permitted under permit no. PMNM-2015-025):
  - a. Multi-beam echo sounder (Kongsberg EM 302) for the purpose of obtaining sea floor topography data.
  - b. Split-beam sonar (Kongsberg EK 60) for the purpose of detecting biological and gaseous targets in the water column.
  - c. Sub-bottom profiler sonar (Knudsen Chirp 3260) for the purpose of interpreting sub-seafloor geology.
  - d. Ultra-short baseline acoustic system (Tracklink TL 10000 MA) for navigating the Deep Discoverer Remote Operated Vehicle (ROV).
  - e. Conductivity-Temperature-Depth (CTD) instrument.
3. Deploying and operating the Deep Discoverer ROV for the purpose of characterizing deep (> 250 meters depth) underwater sites.
4. Touching coral, living or dead while operating the ROV in Activity # 3.
5. Photographing and recording video of marine resources through the operation of the ROV in Activity # 3.
6. Conducting deployments of up to 218 Deep Blue expendable bathythermographs (XBTs) for the purpose of calibrating mapping instruments, and depositing XBTs on the sea floor upon deployment completion.
7. Removing, moving, taking, harvesting, possessing, or attempting to move, take, harvest, or possess two (2) rock samples per ROV dive site (up to 40 sites).
8. Removing, moving, taking, harvesting, possessing, or attempting to move, take, harvest, or possess a set number of any visually observable marine organism morphotype, which cannot be visually identified or may represent a new geographic record or new species, from each of the Permitted Activity Location areas defined, based upon the abundance criteria below:
  - a. One (1) specimen can be taken, removed, or possessed if an abundance assessment cannot be ascertained, or fewer than ten (10) such specimens are present, cumulative during the course of the collection event per location;
  - b. Up to three (3) specimens can be taken, removed, or possessed if an abundance assessment of ten (10) or more of such specimens is ascertained, cumulative during the course of the collection event per location;



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- c. For clonal organisms that cannot be visually identified or may represent a new geographic record or new species, take shall be limited to no more than half the clonal organism visually observed. Up to three (3) clonal specimens of similar morphology can be taken, removed, or possessed if an abundance assessment of ten (10) or more of such specimens is ascertained, cumulative during the course of the collection event per location.

9. Sharing rock samples collected under Permitted Activity # 8, with the following researchers:

- i. Michael Garcia (mogarcia@hawaii.edu), University of Hawai'i, Post 617D, Honolulu, HI 96822
- ii. David Clague (clague@mbari.org), Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road, Moss Landing, CA 95039
- iii. James Hein (jhein@usgs.org), U.S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025
- iv. Christopher Kelley (ckelley@hawaii.edu), University of Hawai'i, 1000 Pope Rd., MSB 229, Honolulu, HI 96822

10. Sharing of biological specimens collected under Permitted Activity # 9, with the following researchers:

- i. Christopher Kelley (ckelley@hawaii.edu), University of Hawai'i, 1000 Pope Rd., MSB 229, Honolulu, HI 96822
- ii. Steve Cairns (cairns@si.edu), National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, MRC 163, Washington, DC 20013-7012
- iii. Holly Bollick (holly@bishopmuseum.org), Bernice Pauahi Bishop Museum, 1525 Bernice Street, Honolulu, HI 96817
- iv. Henry Reiswig (hmreiswig@shaw.ca), University of Victoria, 3800 Finnerty Road, Victoria BC V8P 5C2 Canada
- v. Christopher Mah (brisinga@gmail.com), National Museum of Natural History, Smithsonian Institution, P.O. Box 37012, MRC 163, Washington, DC 20013-7012

11. The Monument Management Board (MMB) may monitor activities under the permit. Any member of the MMB or their designee may, for a period not to exceed 48 hours, verbally require the permittee to temporarily modify or temporarily cease activities identified in the permit if, in the opinion of the MMB member or their designee, such



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action is necessary to limit effects on Monument resources beyond the intended scope of the permit, to protect governmental equipment, or to ensure the safety of personnel. Such action will be followed as soon as possible by MMB emergency consideration of the temporary permit modification or temporary permit cessation. If the MMB concurs with the temporary action taken by the MMB member or designee, the Co-Trustees may amend the permit with the necessary changes or withdraw it. A decision by the Co-Trustees to amend the permit or to allow the activity to continue unchanged will include the necessary findings that the activity and its effects satisfy Monument permit issuance criteria and do not risk the safety of governmental employees or damage to governmental equipment.

No further disturbance of the cultural or natural resources of the Monument is allowed.

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## PERMITTED ACTIVITY LOCATIONS:

Other than entrance into the Monument, the permitted activities listed shall take place within marine areas greater than 250 meters depth throughout the Monument including the Midway Atoll Special Management Area and the following Special Preservation Areas:

1. Nihoa Island
2. Mokumanamana (Necker) Island
3. French Frigate Shoals
4. Gardner Pinnacles
5. Maro Reef
6. Laysan Island
7. Lisianski Island
8. Pearl and Hermes Atoll
9. Kure Atoll

## GENERAL TERMS AND CONDITIONS:

In accordance with the Proclamation and applicable regulations, the permitted activities listed above are subject to the following general terms and conditions:

1. The permittee must sign and date this permit on the appropriate line below. Once signed and dated, the permittee must provide a signed original copy to the Monument official identified below. The permit becomes valid on the date the last signature is obtained and shall remain valid until the permit expiration date.

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2. This permit is neither transferable nor assignable and must be carried by the permittee while engaging in any activity authorized by this permit. All other persons entering the Monument under the authority of this permit must provide the name of the permittee or the permit number to any authorized enforcement or management personnel upon request.
3. This permit may only be modified by written amendment approved by the Co-Trustees. Modifications to this permit must be requested in the same manner as the original request was made. Any modifications requested by the permittee, such as adding or changing personnel to be covered by the permit or to change the activities that are allowed, must be made in writing.
4. This permit is subject to suspension, modification, non-renewal, or revocation for violation of the Proclamation, implementing regulations, or any term or condition of the

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permit. Any verbal notification of a violation from an authorized Monument representative may require immediate cessation of activities within the Monument. The issuance of a permit shall not constitute a vested or property right to receive additional or future permits. This permit may, in the sole discretion of the Co-Trustees, be renewed or reissued. However, there is no right to a renewal or re-issuance. Failure to fulfill permit requirements may affect consideration of future permit applications.

5. Permit terms and conditions shall be treated as severable from all other terms and conditions contained in this or any other ancillary permit. In the event that any provision of this permit is found or declared to be invalid or unenforceable, such invalidity or unenforceability shall not affect the validity or enforceability of the remaining terms or conditions of this permit.
6. This permit does not relieve the permittee of responsibility to comply with all federal, state and local laws and regulations. For a list of federal, state and local laws and regulations, refer to attached Papahānaumokuākea Marine National Monument Laws and Regulations document. Activities under this permit may be conducted only after any other permits or authorizations necessary to conduct the activities have been obtained.
7. The permittee may be held liable for the actions of all persons entering the Monument under the authority of this permit.
8. All persons entering the Monument under the authority of this permit are considered under the supervision of the permittee and may be liable in addition to the permittee for any violation of this permit, the Proclamation and implementing regulations in conjunction with this permit. The permittee must ensure that all such persons have been fully informed of the permit terms and conditions prior to entry into the Monument. Each such person must provide written acknowledgment to the permittee, prior to entry into the Monument, that he/she has received a copy of the permit, agrees to abide by all applicable terms and conditions, and may be liable for violations of the permit. The permittee shall maintain all signed acknowledgments and submit them with the summary report described in General Condition #22.b. An acknowledgement form is attached.
9. Notification of entry into the Monument must be provided at least 72 hours, but no longer than one month, prior to the entry date. Any updates to the list of personnel must also be provided at least 72 hours before entering the Monument. Notification of departure from the Monument must be provided within 12 hours of leaving the Monument. Notification may be made via e-mail or telephone by contacting: E-mail: [nwhi.notifications@noaa.gov](mailto:nwhi.notifications@noaa.gov); Telephone: 1-866-478-6944; or 1-808-395-6944. No other methods of notification will be considered valid.
10. The permittee and any person entering the Monument under the authority of this permit shall, before entering the Monument, attend a cultural briefing or view designated cultural informational materials on Papahānaumokuākea regarding the region's cultural significance and Native Hawaiians' spiritual and genealogical connection to the natural

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and cultural resources. Persons entering the Monument at Midway Atoll may satisfy this requirement upon arrival.

11. All vessels (including tenders and dive boats), engines and anchor lines shall be free of introduced species prior to entry into the Monument. To ensure this, all vessels, engines and anchor lines shall be inspected for potential introduced species prior to departing the last port before entering the Monument. No later than 24 hours prior to entry, the permittee shall provide the Monument Permit Coordinator with a report prepared by the individual conducting the inspection that: a) sets forth when and where the inspection occurred; b) identifies any introduced species observed, including where found; c) summarizes efforts to remove any species observed; and d) certifies the vessel as free of all introduced species. The Monument Permit Coordinator shall review the report and, based on the review, may delay the entry into the Monument until all concerns identified by the Monument Permit Coordinator have been addressed.
12. All hazardous materials, biohazards and sharps, must be pre-approved by the Co-Trustees. For purposes of this permit, "hazardous material" has the same meaning as the definition found at 49 CFR §105.5 (U.S. Department of Transportation). All hazardous materials, biohazards and sharps must be stored, used, and disposed of according to applicable laws and Monument-approved protocols. The permittee or a designated individual entering the Monument under the authority of this permit must be properly trained in the use and disposal of all such materials proposed. Proof of appropriate training may be required by the Co-Trustees. No such material may be left in the Monument after the departure of the permittee unless it has been previously approved by Monument staff. Immediately after the project is complete the permittee must remove all such materials from the Monument. The permittee will be responsible for all costs associated with use, storage, transport, training, disposal, or HazMat response for these materials.
13. All equipment or supplies brought into the Monument, or structures of any kind built in the Monument by the permittee are the responsibility of the permittee. All materials that are brought to the Monument by the permittee must be removed by the permittee except as otherwise permitted. Any permanent structures, equipment, or supplies that require maintenance, are determined to be unserviceable, or are a safety hazard, must be immediately repaired or removed from the Monument by the permittee. No structures, equipment, or supplies may be left in the Monument following the completion of the project except as listed in the permit.
14. If Monument staff is present at the field site, the permittee must meet with them before beginning permitted activities. Even with a valid permit, authorized Monument staff may prohibit entry into any location(s) within the Monument as they may deem appropriate to conserve or manage resources, particularly in areas where cumulative impacts of permitted activities are concentrated.
15. In order to facilitate monitoring and compliance, any person entering the Monument under the authority of this permit, including assistants and ship's crew shall, upon request

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by authorized Monument enforcement personnel, promptly: a) allow access to and inspection of any vessel or facility used to carry out permit activities; b) produce for inspection any sample, record, or document related to permit activities, including data, logs, photos, and other documentation obtained under, or required by, this permit; and c) allow inspection on board the vessel or at the permittee's premises of all organisms, parts of organisms, and other samples collected under this permit.

16. It is prohibited to possess or consume alcohol in the Hawaiian Islands National Wildlife Refuge in accordance with the refuge policy. Any violations will result in immediate removal of the offender from the Monument at the individual's own cost. Offenders may not be readmitted to the Monument.
17. All persons entering the Monument under the authority of this permit are responsible for the cost of removing themselves from the Monument at the conclusion of the term of the permit or upon revocation or suspension of the permit. All such persons are also responsible for the cost of removing themselves from the Monument in the event of a necessary medical evacuation, emergency evacuation, including weather, or for the cost of any necessary search and rescue operation.
18. Except as expressly required by applicable law, the Co-Trustees are not liable for any damages to equipment or injuries to the permittee and persons entering the Monument under the authority of this permit. The permittee and any person entering the Monument under the authority of this permit shall release, indemnify, and hold harmless the National Oceanic and Atmospheric Administration, the Department of Commerce, the U.S. Fish and Wildlife Service, the Department of the Interior, the United States Government, the State of Hawai'i, and their respective employees and agents acting within the scope of their duties from and against any claims, demands, actions, liens, rights, subrogated or contribution interests, debts, liabilities, judgments, costs, and attorney's fees, arising out of, claimed on account of, or in any manner predicated upon the issuance of this permit or the entry into or habitation upon the Monument or as the result of any action of the permittee or persons participating in the activity authorized by this permit. In the event that a government employee, acting in his official capacity, is the permittee, or is entering the Monument under the authority of this permit, then he shall be subject to all applicable federal and State laws that pertain to claims by or against him predicated upon the issuance of this permit or entry into or habitation upon the Monument.
19. Monument managers or their designees may verbally require the permittee to modify or cease activities not identified in this permit if, in the opinion of the managers or designees, such action is necessary to limit disturbance to or protect Monument resources, to protect government equipment, or to ensure the safety of personnel. After providing such verbal instructions, the managers or designees will provide the permittee with a written modification, suspension or revocation to this permit at the earliest practicable opportunity. The failure to follow verbal instructions or modified permit terms, or to cease activities upon suspension or revocation of this permit, may constitute a violation of this permit, the Proclamation, the regulations, or other applicable law.

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20. Disturbance of any cultural or historic property, including but not limited to Native Hawaiian cultural sites, burials, archaeological deposits, and WWII structures and features, such as stone walls and mounds, stone uprights, bunkers, batteries, camp sites, maritime heritage sites, hospitals, housing areas, and radio towers; or the disturbance or collection of any historic or cultural materials and artifacts, including but not limited to bottles, dishes, cartridges, hospital materials, carvings, human remains, or Native Hawaiian bone or stone implements, found within the Monument, including the sale or trade in such items, is prohibited.
21. All Monument resources within the jurisdiction of the State of Hawai'i are held in trust under the Hawai'i State Constitution, Article XI, Sec. 1. The State of Hawai'i and the Government of the United States reserve ownership or control, as the case may be, of Monument resources, both living and nonliving, that may be taken or derived from those found in the Monument.
22. The permittee must satisfy the following reporting requirements:
  - a. Within thirty (30) days after the expiration date of this permit, the permittee must submit a summary report of activities conducted under this permit. The report shall be submitted using the Monument permit report template, if applicable.
  - b. For permitted vessels, the permittee having authority over the vessel must maintain and submit a cruise log within thirty (30) days after the expiration date of this permit. The log shall include but is not limited to: description of cruise activities, geographic locations of those activities, anchoring locations, and small boat dive locations. The permittee shall also maintain a daily vessel discharge log, which must be submitted with the cruise log.
  - c. Annual Report. The comprehensive annual report is a summary of all activities undertaken, including but not limited to: dates of all arrivals and departures from islands and atolls within the Monument, names of all persons involved in permitted activities, details of all specimens collected, handled, etc., any other pertinent information, GPS locations of all samples collected, transects, etc., results of work to date, copy of all data collected, and a proposed schedule of publication or production of final work. The report shall include a concise summary or abstract for use in Monument reports. Two hard copies and one electronic copy (Microsoft Word preferred, but not required), must be submitted to the Co-Trustees. The annual report is due by December 31 for each calendar year the permit was in effect. Subsequent annual reports are requested each year until all data collected under research permits are fully analyzed or before a new permit is issued, whichever comes first.
  - d. For activities on State lands or within State waters, the permittee must submit a monthly report on the specified form.



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- e. The permittee may debrief the Co-Trustees following the completion of all activities in the Monument covered under this permit. The permittee may schedule the debriefing upon submitting the annual report.
  - f. The permittee must submit two copies of any article, publication, or other product created as a result of the information gained or work completed under this permit, including materials generated at any time in the future following expiration of this permit.
  - g. Any publications and/or reports resulting from activities conducted under the authority of this permit must include the notation that the activity was conducted under permit number PMNM-2015-018. This requirement does not apply to publications or reports produced by the news media.
  - h. All required submissions (including plans, logs, reports, and publications) shall be provided to the Monument official at the address indicated in General Condition #1.
23. All data acquired or created in conjunction with this permit will be submitted with the summary report, and annual report. Photographic and video material is considered data. The permittee retains ownership of any data, (including but not limited to any photographic or video material), derivative analyses, or other work product, or other copyrightable works, but the Federal Government and the State of Hawai'i retain a lifetime, non-exclusive, worldwide, royalty-free license to use the same for government purposes, including copying and redissemination, and making derivative works. The permittee will receive acknowledgment as to its ownership of the data in all future use. This requirement does not apply to data acquired or created by the news media.
24. Because photographic or video material that is created for personal use (i.e., not specifically acquired or created in conjunction with this permit) could unintentionally collect data that is also valuable for management purposes, the Co-Trustees reserve the right to request copies of any such material and the permittee agrees to provide a copy of such material within a reasonable time. The Co-Trustees may use such material for management purposes.
25. Any question of interpretation of any term or condition of this permit will be resolved by the Co-Trustees.



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## SPECIAL TERMS AND CONDITIONS:

1. This permit is not to be used for nor does it authorize the sale of collected organisms. Under this permit, the authorized activities must be for noncommercial purposes not involving the use or sale of any organism, by-products, or materials collected within the Monument for obtaining patent or intellectual property rights.
2. The permittees may not convey, transfer, or distribute, in any fashion (including, but not limited to, selling, trading, giving, or loaning) any coral, live rock, or organism collected under this permit without the express written permission of the Co-Trustees.
3. Tenders and small vessels must be equipped with engines that meet EPA emissions requirements.
4. Refueling of tenders and all small vessels must be done at the support ship and outside the confines of lagoons or near-shore waters in the State Marine Refuge.
5. No fishing is allowed in State waters except as authorized under State law for subsistence, traditional and customary practices by Native Hawaiians.
6. Observers shall monitor for the presence of Federally-listed marine species at all times.
7. Unless specifically covered under a separate permit that allows activity in proximity to marine protected species, all mapping will be postponed, meaning the vessel would stop when whales and other protected species are within 400 meters of the ship, and magnetometer would be retrieved. Vessel will resume mapping operations only after the animal(s) depart the area.
8. To ensure the protection of Monument resources, the permittee must conduct all activities in accordance with the following Monument Best Management Practices (BMPs) and guidelines, as attached:
  - a. Best Management Practices for Boat Operations and Diving Activities (BMP #004)
  - b. Marine Wildlife Viewing Guidelines (BMP #010)

NOAA/Daniel K. Inouye Regional Center  
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Your signature below, as permittee, indicates that you accept and agree to comply with all terms and conditions of this permit. This permit authorizes only those activities listed above. This permit becomes valid on the date when signed by the last Monument Official. Please note that the expiration date on this permit will not be extended by a delay in your signing below.

\_\_\_\_\_  
Kelly Elliott  
NOAA Office of Ocean Exploration and Research

\_\_\_\_\_  
Date

Attachments (5):

1. Map of the Papahānaumokuākea Marine National Monument (PMNM)
2. PMNM Rules and Regulations
3. Permit Acknowledgement Form
4. Best Management Practices for Boat Operations and Diving Activities (BMP #004)
5. Marine Wildlife Viewing Guidelines (BMP #010)

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\_\_\_\_\_  
Suzanne Case  
Chairperson  
Board of Land and Natural Resources  
Department of Land and Natural Resources  
State of Hawaii

6/29/15  
Date



NOAA/Daniel K. Inouye Regional Center  
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Barry Stieglitz  
Refuge and Monument Supervisor  
Hawaiian & Pacific Islands National Wildlife Refuge  
Complex  
Department of the Interior  
U.S. Fish and Wildlife Service

  
Date



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*[Handwritten signature]*

6-30-2015

Athline Clark  
Superintendent  
Papahānaumokuākea Marine National Monument  
Department of Commerce  
National Oceanic and Atmospheric Administration

Date



NOAA/Daniel K. Inouye Regional Center  
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# Ocean Exploration and Research

## Appendix E: PMNM Permit – Ship Operations

PMNM-2015-018-L  
Elliott:



Ms. Kelley Elliott  
NOAA Office of Ocean Exploration and Research  
1315 East-West HWY, SSMC3 Room 10236  
Silver Spring, MD 20910

JUL 01 2015

Dear Ms. Elliott:

The National Oceanic and Atmospheric Administration (NOAA), the U.S. Fish and Wildlife Service (FWS), and the State of Hawaii (collectively, the Co-Trustees) have approved the issuance of permit number PMNM-2015-018 to conduct activities within Papahānaumokuākea Marine National Monument ("Monument") for research purposes. Activities are to be conducted in accordance with the permit application and all supporting materials submitted to the Monument, and the terms and conditions of permit number PMNM 2015 018 attached.

Enclosed for your signature is a permit signed by all Co-Trustees. This permit is not valid until your signature page is received at this office. The original copy should be signed and returned to the Monument office at the following address within 30 days of issuance:

NOAA/Daniel K. Inouye Regional Center  
NOS/ONMS/PMNM/ATTN: Permit Coordinator  
1845 Wasp Blvd., Building 176  
Honolulu, HI 96818

You are required to carry a signed copy of the permit with you while conducting the permitted activities. Your permit contains specific special conditions and reporting requirements. Please review them closely and fully comply with them while undertaking permitted activities.

The Point of Contact for questions concerning this permit and all associated reporting requirements is Permits and Policy Specialist, Justin Rivera at 808-725-5831 or [Justin.Rivera@noaa.gov](mailto:Justin.Rivera@noaa.gov). Thank you for your continued cooperation with NOAA, FWS, and the State of Hawaii.

  
\_\_\_\_\_  
Suzanne Case  
Chairperson  
Board of Land and Natural Resources  
Department of Land and Natural Resources  
State of Hawaii

8/29/15  
Date



NOAA/Daniel K. Inouye Regional Center  
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*23*  
\_\_\_\_\_  
Date *7/1/15*

Barry Stieglitz  
Refuge and Monument Supervisor  
Hawaiian and Pacific Islands National Wildlife Refuge Complex  
Department of the Interior  
U.S. Fish and Wildlife Service



NOAA/Daniel K. Inouye Regional Center  
NOS/DNMS/ Papahānaumokuākea Marine National Monument  
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*Athline Clark*  
for 6-30-2015

\_\_\_\_\_  
Athline Clark  
Superintendent  
Papahānaumokuākea Marine National Monument  
Department of Commerce  
National Oceanic and Atmospheric Administration



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**PAPAHĀNAUMOKUĀKEA**  
**Marine National Monument**

JUL 01 2015

**CONSERVATION AND MANAGEMENT PERMIT**

**Permittee:**  
CDR Mark Wetzler  
NOAA Ship OKEANOS EXPLORER  
1897 Ranger Loop  
Honolulu, HI 96818

**Permit Number:** PMNM-2015-025  
**Effective Date:** July 1, 2015  
**Expiration Date:** June 30, 2016

**Project Title:** Support for Permitted Activities Aboard NOAA Ship OKEANOS EXPLORER

This permit is issued for activities in accordance with Proclamation 8031 ("Proclamation") establishing Papahānaumokuākea Marine National Monument ("Monument") under the Antiquities Act of 1906, 16 USC §§ 431-433 ("Antiquities Act") and implementing regulations (50 CFR Part 404). All activities must be conducted in accordance with the Proclamation and the regulations (attached). No activity prohibited by the Proclamation or 50 CFR Part 404 is allowed except as specified below. Chapter 13-60.5, Hawaii Administrative Rules remains in effect for proposed activities in State waters.

Subject to the terms and conditions of this permit, the National Oceanic and Atmospheric Administration (NOAA), the State of Hawaii, and the U.S. Fish and Wildlife Service (collectively, the Co-Trustees) hereby authorize the permittee listed above to conduct conservation and management activities within the Monument. All activities are to be conducted in accordance with this permit. The permit application is incorporated into this permit and made a part hereof; provided, however, that if there are any conflicts between the permit application and the terms and conditions of this permit, the terms and conditions of this permit shall be controlling.

**PERMITTED ACTIVITY DESCRIPTIONS:**

The following activities are authorized by this permit:

1. The permittee and twenty-five (25) individuals from the following list are authorized to enter Papahānaumokuākea Marine National Monument ("PMNM" or "Monument") and conduct activities under this permit: One (1) Executive Officer, One (1) Operations Officer, One (1) Navigation Officer, One (1) Third Mate, One (1) Environmental Compliance Officer, One (1) Augmenting Officer, One (1) Medical Officer, One (1) Chief Marine Engineer, One (1) 1<sup>st</sup> Assistant Engineer, One (1) 2<sup>nd</sup> Assistant Engineer, One (1) Engine Utilityman, Three (3) General Vessel Assistants, One (1) Chief Boatswain, One (1) Boatswain Group Leader, Three (3) Able Bodied Seamen, One (1)

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Chief Steward, One (1) Chief Cook, One (1) Second Cook, One (1) Survey Technician, One (1) Electronics Technician, and One (1) Rotating Electronics Technician. Permittee shall provide an updated Compliance Information Sheet prior to each entry into the Monument.

2. Entering of NOAA Ship OKEANOS EXPLORER into the Monument for the purpose of supporting separately permitted activities.
3. Operating the following shipboard instruments to support research activities authorized under permit no. PMNM-2015-018.
  - a. Multi-beam echo sounder (Kongsberg EM 302) for the purpose of obtaining sea floor topography data.
  - b. Split-beam sonar (Kongsberg EK 60) for the purpose of detecting biological and gaseous targets in the water column.
  - c. Sub-bottom profiler sonar (Knudsen Chirp 3260) for the purpose of interpreting sub-seafloor geology.
  - d. Ultra short baseline acoustic system (Tracklink TL 10000 MA).
  - e. One Conductivity-Temperature-Depth (CTD) instrument .
4. Assisting in deployments of the Deep Discoverer Remote Operated Vehicle (ROV). ROV operations separately permitted under permit no. PMNM-2015-018.
5. Discharging gray water outside of all Special Preservation Areas and the Midway Atoll Special Management Area. Gray water is defined as including drainage from dishwasher, shower, laundry, bath and washbasin drains.
6. Swimming, snorkeling and SCUBA diving necessary for vessel maintenance, proficiency, emergency operations, and non-recreational support of vessel activities.
7. The Monument Management Board (MMB) may monitor activities under the permit. Any member of the MMB or their designee may, for a period not to exceed 48 hours, verbally require the permittee to temporarily modify or temporarily cease activities identified in the permit if, in the opinion of the MMB member or their designee, such action is necessary to limit effects on Monument resources beyond the intended scope of the permit, to protect governmental equipment, or to ensure the safety of personnel. Such action will be followed as soon as possible by MMB emergency consideration of the temporary permit modification or temporary permit cessation. If the MMB concurs with the temporary action taken by the MMB member or designee, the Co-Trustees may amend the permit with the necessary changes or withdraw it. A decision by the Co-Trustees to amend the permit or to allow the activity to continue unchanged will include the necessary findings that the activity and its effects satisfy Monument permit issuance

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criteria and do not risk the safety of governmental employees or damage to governmental equipment.

No further disturbance of the cultural or natural resources of the Monument is allowed.

### PERMITTED ACTIVITY LOCATIONS:

Other than entrance into the Monument, the permitted activities listed shall take place within marine areas greater than 250 meters depth throughout the Monument including the Midway Atoll Special Management Area and the following Special Preservation Areas:

1. Nihoa Island
2. Mokumanamana (Necker) Island
3. French Frigate Shoals
4. Gardner Pinnacles
5. Maro Reef
6. Laysan Island
7. Lisianski Island
8. Pearl and Hermes Atoll
9. Kure Atoll

### GENERAL TERMS AND CONDITIONS:

In accordance with the Proclamation and applicable regulations, the permitted activities listed above are subject to the following general terms and conditions:

1. The permittee must sign and date this permit on the appropriate line below. Once signed and dated, the permittee must provide a signed original copy to the Monument official identified below. The permit becomes valid on the date the last signature is obtained and shall remain valid until the permit expiration date.

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 National Monument  
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2. This permit is neither transferable nor assignable and must be carried by the permittee while engaging in any activity authorized by this permit. All other persons entering the Monument under the authority of this permit must provide the name of the permittee or the permit number to any authorized enforcement or management personnel upon request.
3. This permit may only be modified by written amendment approved by the Co-Trustees. Modifications to this permit must be requested in the same manner as the original request

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was made. Any modifications requested by the permittee, such as adding or changing personnel to be covered by the permit or to change the activities that are allowed, must be made in writing.

4. This permit is subject to suspension, modification, non-renewal, or revocation for violation of the Proclamation, implementing regulations, or any term or condition of the permit. Any verbal notification of a violation from an authorized Monument representative may require immediate cessation of activities within the Monument. The issuance of a permit shall not constitute a vested or property right to receive additional or future permits. This permit may, in the sole discretion of the Co-Trustees, be renewed or reissued. However, there is no right to a renewal or re-issuance. Failure to fulfill permit requirements may affect consideration of future permit applications.
5. Permit terms and conditions shall be treated as severable from all other terms and conditions contained in this or any other ancillary permit. In the event that any provision of this permit is found or declared to be invalid or unenforceable, such invalidity or unenforceability shall not affect the validity or enforceability of the remaining terms or conditions of this permit.
6. This permit does not relieve the permittee of responsibility to comply with all federal, state and local laws and regulations. For a list of federal, state and local laws and regulations, refer to attached Papahānaumokuākea Marine National Monument Laws and Regulations document. Activities under this permit may be conducted only after any other permits or authorizations necessary to conduct the activities have been obtained.
7. The permittee may be held liable for the actions of all persons entering the Monument under the authority of this permit.
8. All persons entering the Monument under the authority of this permit are considered under the supervision of the permittee and may be liable in addition to the permittee for any violation of this permit, the Proclamation and implementing regulations in conjunction with this permit. The permittee must ensure that all such persons have been fully informed of the permit terms and conditions prior to entry into the Monument. Each such person must provide written acknowledgment to the permittee, prior to entry into the Monument, that he/she has received a copy of the permit, agrees to abide by all applicable terms and conditions, and may be liable for violations of the permit. The permittee shall maintain all signed acknowledgments and submit them with the summary report described in General Condition #22.b. An acknowledgement form is attached.
9. Notification of entry into the Monument must be provided at least 72 hours, but no longer than one month, prior to the entry date. Any updates to the list of personnel must also be provided at least 72 hours before entering the Monument. Notification of departure from the Monument must be provided within 12 hours of leaving the Monument. Notification may be made via e-mail or telephone by contacting: E-mail:

NOAA/Daniel K. Inouye Regional Center  
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nwhi.notifications@noaa.gov; Telephone: 1-866-478-6944; or 1-808-395-6944. No other methods of notification will be considered valid.

10. The permittee and any person entering the Monument under the authority of this permit shall, before entering the Monument, attend a cultural briefing or view designated cultural informational materials on Papahānaumokuākea regarding the region's cultural significance and Native Hawaiians' spiritual and genealogical connection to the natural and cultural resources. Persons entering the Monument at Midway Atoll may satisfy this requirement upon arrival.
11. All vessels (including tenders and dive boats), engines and anchor lines shall be free of introduced species prior to entry into the Monument. To ensure this, all vessels, engines and anchor lines shall be inspected for potential introduced species prior to departing the last port before entering the Monument. No later than 24 hours prior to entry, the permittee shall provide the Monument Permit Coordinator with a report prepared by the individual conducting the inspection that: a) sets forth when and where the inspection occurred; b) identifies any introduced species observed, including where found; c) summarizes efforts to remove any species observed; and d) certifies the vessel as free of all introduced species. The Monument Permit Coordinator shall review the report and, based on the review, may delay the entry into the Monument until all concerns identified by the Monument Permit Coordinator have been addressed.
12. All hazardous materials, biohazards and sharps, must be pre-approved by the Co-Trustees. For purposes of this permit, "hazardous material" has the same meaning as the definition found at 49 CFR §105.5 (U.S. Department of Transportation). All hazardous materials, biohazards and sharps must be stored, used, and disposed of according to applicable laws and Monument-approved protocols. The permittee or a designated individual entering the Monument under the authority of this permit must be properly trained in the use and disposal of all such materials proposed. Proof of appropriate training may be required by the Co-Trustees. No such material may be left in the Monument after the departure of the permittee unless it has been previously approved by Monument staff. Immediately after the project is complete the permittee must remove all such materials from the Monument. The permittee will be responsible for all costs associated with use, storage, transport, training, disposal, or HazMat response for these materials.
13. All equipment or supplies brought into the Monument, or structures of any kind built in the Monument by the permittee are the responsibility of the permittee. All materials that are brought to the Monument by the permittee must be removed by the permittee except as otherwise permitted. Any permanent structures, equipment, or supplies that require maintenance, are determined to be unserviceable, or are a safety hazard, must be immediately repaired or removed from the Monument by the permittee. No structures, equipment, or supplies may be left in the Monument following the completion of the project except as listed in the permit.

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14. If Monument staff is present at the field site, the permittee must meet with them before beginning permitted activities. Even with a valid permit, authorized Monument staff may prohibit entry into any location(s) within the Monument as they may deem appropriate to conserve or manage resources, particularly in areas where cumulative impacts of permitted activities are concentrated.
15. In order to facilitate monitoring and compliance, any person entering the Monument under the authority of this permit, including assistants and ship's crew shall, upon request by authorized Monument enforcement personnel, promptly: a) allow access to and inspection of any vessel or facility used to carry out permit activities; b) produce for inspection any sample, record, or document related to permit activities, including data, logs, photos, and other documentation obtained under, or required by, this permit; and c) allow inspection on board the vessel or at the permittee's premises of all organisms, parts of organisms, and other samples collected under this permit.
16. It is prohibited to possess or consume alcohol in the Hawaiian Islands National Wildlife Refuge in accordance with the refuge policy. Any violations will result in immediate removal of the offender from the Monument at the individual's own cost. Offenders may not be readmitted to the Monument.
17. All persons entering the Monument under the authority of this permit are responsible for the cost of removing themselves from the Monument at the conclusion of the term of the permit or upon revocation or suspension of the permit. All such persons are also responsible for the cost of removing themselves from the Monument in the event of a necessary medical evacuation, emergency evacuation, including weather, or for the cost of any necessary search and rescue operation.
18. Except as expressly required by applicable law, the Co-Trustees are not liable for any damages to equipment or injuries to the permittee and persons entering the Monument under the authority of this permit. The permittee and any person entering the Monument under the authority of this permit shall release, indemnify, and hold harmless the National Oceanic and Atmospheric Administration, the Department of Commerce, the U.S. Fish and Wildlife Service, the Department of the Interior, the United States Government, the State of Hawai'i, and their respective employees and agents acting within the scope of their duties from and against any claims, demands, actions, liens, rights, subrogated or contribution interests, debts, liabilities, judgments, costs, and attorney's fees, arising out of, claimed on account of, or in any manner predicated upon the issuance of this permit or the entry into or habitation upon the Monument or as the result of any action of the permittee or persons participating in the activity authorized by this permit. In the event that a government employee, acting in his official capacity, is the permittee, or is entering the Monument under the authority of this permit, then he shall be subject to all applicable federal and State laws that pertain to claims by or against him predicated upon the issuance of this permit or entry into or habitation upon the Monument.

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19. Monument managers or their designees may verbally require the permittee to modify or cease activities not identified in this permit if, in the opinion of the managers or designees, such action is necessary to limit disturbance to or protect Monument resources, to protect government equipment, or to ensure the safety of personnel. After providing such verbal instructions, the managers or designees will provide the permittee with a written modification, suspension or revocation to this permit at the earliest practicable opportunity. The failure to follow verbal instructions or modified permit terms, or to cease activities upon suspension or revocation of this permit, may constitute a violation of this permit, the Proclamation, the regulations, or other applicable law.
20. Disturbance of any cultural or historic property, including but not limited to Native Hawaiian cultural sites, burials, archaeological deposits, and WWII structures and features, such as stone walls and mounds, stone uprights, bunkers, batteries, camp sites, maritime heritage sites, hospitals, housing areas, and radio towers; or the disturbance or collection of any historic or cultural materials and artifacts, including but not limited to bottles, dishes, cartridges, hospital materials, carvings, human remains, or Native Hawaiian bone or stone implements, found within the Monument, including the sale or trade in such items, is prohibited.
21. All Monument resources within the jurisdiction of the State of Hawai'i are held in trust under the Hawai'i State Constitution, Article XI, Sec. 1. The State of Hawai'i and the Government of the United States reserve ownership or control, as the case may be, of Monument resources, both living and nonliving, that may be taken or derived from those found in the Monument.
22. The permittee must satisfy the following reporting requirements:
  - a. Within thirty (30) days after the expiration date of this permit, the permittee must submit a summary report of activities conducted under this permit. The report shall be submitted using the Monument permit report template, if applicable.
  - b. For permitted vessels, the permittee having authority over the vessel must maintain and submit a cruise log within thirty (30) days after the expiration date of this permit. The log shall include but is not limited to: description of cruise activities, geographic locations of those activities, anchoring locations, and small boat dive locations. The permittee shall also maintain a daily vessel discharge log, which must be submitted with the cruise log.
  - c. Annual Report. The comprehensive annual report is a summary of all activities undertaken, including but not limited to: dates of all arrivals and departures from islands and atolls within the Monument, names of all persons involved in permitted activities, details of all specimens collected, handled, etc., any other pertinent information, GPS locations of all samples collected, transects, etc., results of work to date, copy of all data collected, and a proposed schedule of publication or production of final work. The report shall include a concise summary or abstract for use in

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Monument reports. Two hard copies and one electronic copy (Microsoft Word preferred, but not required), must be submitted to the Co-Trustees. The annual report is due by December 31 for each calendar year the permit was in effect. Subsequent annual reports are requested each year until all data collected under research permits are fully analyzed or before a new permit is issued, whichever comes first.

d. For activities on State lands or within State waters, the permittee must submit a monthly report on the specified form.

e. The permittee may debrief the Co-Trustees following the completion of all activities in the Monument covered under this permit. The permittee may schedule the debriefing upon submitting the annual report.

f. The permittee must submit two copies of any article, publication, or other product created as a result of the information gained or work completed under this permit, including materials generated at any time in the future following expiration of this permit.

g. Any publications and/or reports resulting from activities conducted under the authority of this permit must include the notation that the activity was conducted under permit number PMNM-2015-025. This requirement does not apply to publications or reports produced by the news media.

h. All required submissions (including plans, logs, reports, and publications) shall be provided to the Monument official at the address indicated in General Condition #1.

23. All data acquired or created in conjunction with this permit will be submitted with the summary report, and annual report. Photographic and video material is considered data. The permittee retains ownership of any data, (including but not limited to any photographic or video material), derivative analyses, or other work product, or other copyrightable works, but the Federal Government and the State of Hawai'i retain a lifetime, non-exclusive, worldwide, royalty-free license to use the same for government purposes, including copying and dissemination, and making derivative works. The permittee will receive acknowledgment as to its ownership of the data in all future use. This requirement does not apply to data acquired or created by the news media.

24. Because photographic or video material that is created for personal use (i.e., not specifically acquired or created in conjunction with this permit) could unintentionally collect data that is also valuable for management purposes, the Co-Trustees reserve the right to request copies of any such material and the permittee agrees to provide a copy of such material within a reasonable time. The Co-Trustees may use such material for management purposes.

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25. Any question of interpretation of any term or condition of this permit will be resolved by the Co-Trustees.

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## SPECIAL TERMS AND CONDITIONS:

1. Tenders and small vessels must be equipped with engines that meet EPA emissions requirements.
2. Refueling of tenders and all small vessels must be done at the support ship and outside the confines of lagoons or near-shore waters in the State Marine Refuge.
3. No fishing is allowed in State waters except as authorized under State law for subsistence, traditional and customary practices by Native Hawaiians.
4. To prevent introduction of disease or the unintended transport of live organisms, the permittee must comply with the disease and transport protocols attached to this permit.
5. Observers shall monitor for the presence of Federally-listed marine species at all times.
6. Unless specifically covered under a separate permit that allows activity in proximity to marine protected species, all mapping activities will be postponed, meaning the vessel would stop when whales and other protected species are within 400 meters of the ship. Vessel will resume mapping operations only after the animal(s) depart the area.
7. To ensure the protection of Monument resources, the permittee must conduct all activities in accordance with the following Monument Best Management Practices (BMPs) and guidelines, as attached:
  - a. Best Management Practices for Boat Operations and Diving Activities (BMP #004)
  - b. Best Practices for Minimizing the Impact of Artificial Light on Sea Turtles (BMP #009)
  - c. Marine Wildlife Viewing Guidelines (BMP #010)
  - d. Disease and Introduced Species Prevention Protocol for Permitted Activities in the Marine Environment (PMNM BMP # 011)

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Your signature below, as permittee, indicates that you accept and agree to comply with all terms and conditions of this permit. This permit authorizes only those activities listed above. This permit becomes valid on the date when signed by the last Monument Official. Please note that the expiration date on this permit will not be extended by a delay in your signing below.

Mark A. Wetzler Date 7/9/15  
CDR Mark Wetzler  
Commanding Officer  
NOAA Ship OKEANOS EXPLORER

Attachments (7):

1. Map of the Papahānaumokuākea Marine National Monument (PMNM)
2. PMNM Rules and Regulations
3. Permit Acknowledgement Form
4. Best Management Practices for Boat Operations and Diving Activities (BMP #004)
5. Best Practices for Minimizing the Impact of Artificial Light on Sea Turtles (BMP #009)
6. Marine Wildlife Viewing Guidelines (BMP #010)
7. Disease and Introduced Species Prevention Protocol for Permitted Activities in the Marine Environment (PMNM BMP # 011)

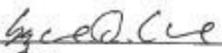
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\_\_\_\_\_  
Suzanne Case  
Chairperson  
Board of Land and Natural Resources  
Department of Land and Natural Resources  
State of Hawaii

  
\_\_\_\_\_  
Date



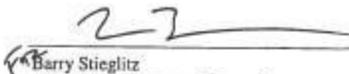
NOAA/Daniel K. Inouye Regional Center  
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Barry Stieglitz  
Refuge and Monument Supervisor  
Hawaiian & Pacific Islands National Wildlife Refuge  
Complex  
Department of the Interior  
U.S. Fish and Wildlife Service

  
Date

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*Athline Clark*  
Athline Clark  
Superintendent  
Papahānaumokuākea Marine National Monument  
Department of Commerce  
National Oceanic and Atmospheric Administration

*6-30-2015*  
Date



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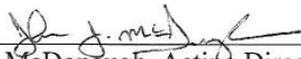
## Appendix F: NEPA Categorical Exclusion Letter

Although the proposed action will occur within a geographic area with unique characteristics, i.e., sensitive ecosystems and historic/cultural resources, it has been determined that the initial discovery and characterization undertaken by this project will not pose the possibility of significant impact and, hence, do not warrant preparation of an EA or EIS, as prescribed in NAO 216.6 Section 5.05c. Arguably, such natural and cultural resources need to be clearly identified, inventoried and assessed in order for managers to effectively manage and protect them. This work supports NOAA and the Co-Trustees of PMNM’s responsibility to preserve and manage natural and historic resources within PMNM as stipulated under Proclamation 8031.

### Effects of the Project

As expected for ocean research with limited duration or presence in the marine environment, this project will not have the potential for significant impacts. Knowledgeable experts who are aware of the sensitivities of the marine environment will conduct the at-sea portions of this project. The potential gains or beneficial effects of the project seem to outweigh any potential adverse effects. This expedition will provide baseline characterization of poorly understood deep water habitats, including within marine protected areas, contained within the U.S. Exclusive Economic Zone (EEZ). This work will provide essential information for further research, exploration, and conservation of marine habitats within the Monument(s).

As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this is a research project of limited size or magnitude and will not result in individually or cumulatively significant impacts on the quality of the human environment. Specifically, this research cruise would have only short-term effects with the principle goals of natural resource inventories and environmental monitoring over a wide geographic area. Furthermore, this action would not be subject to any of the exceptions for categorical exclusion provided at NAO 216-6 section 5.05c. As such, this project is categorically excluded from the need to prepare a NEPA environmental assessment.

Signed:   
John McDonough, Acting Director

Date: July 22 2015



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## Appendix G: ESA Section 7 Letter of Concurrence



U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
NATIONAL MARINE FISHERIES SERVICE  
Pacific Islands Regional Office  
1845 Wasp Blvd., Bldg 176  
Honolulu, Hawaii 96818  
(808) 725-5000 • Fax: (808) 725-5215

JUL 07 2015

Dr. John J. McDonough  
Deputy Director  
National Oceanic and Atmospheric Administration  
Office of Ocean Exploration and Research  
Silver Spring, MD 20910

Dear Dr. McDonough:

This letter responds to your June 10, 2015 Request for Consultation by the NOAA Office of Exploration and Research (OER) regarding efforts aboard the NOAA vessel *Okeanos Explorer* that would include four telepresence-enabled ocean exploration cruises from July to September 2015, to collect critical baseline information to meet NOAA science and management needs within the Hawaiian Archipelago and offshore Johnston Atoll. You have requested our concurrence under Section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. §1531 et seq.), with your determination that the proposed action may affect but is not likely to adversely affect green, hawksbill, leatherback, olive ridley, and north Pacific loggerhead sea turtles; Main Hawaiian Islands false killer whale distinct population segment, humpback whales, blue whales, fin whales, sei whales, sperm whales, north Pacific right whales, the Indo-West Pacific distinct population segments of the scalloped hammerhead shark, Hawaiian monk seals, and monk seal critical habitat.

**Proposed Action/Action Area:** The proposed activities are described in the OER request for consultation and the associated biological evaluation (CAPSTONE 2015). In summary, the proposed action consists of activities to explore and improve understanding of the distribution and diversity of deep water habitats. The activities would occur during four different research cruises aboard the *Okeanos Explorer* scheduled between July – October 2015. No activities would occur on land. Up to 60 individuals (20 rotating scientists/technicians on 3 expedition legs) would be authorized to conduct mapping and ROV surveys using the vessel’s multibeam, single beam and subbottom profiling sonar systems, conducting conductivity-temperature depth (CTD) casts, and deploying an ROV.

The action area covered by this biological evaluation encompasses the marine environment of the Papahānaumokuākea Marine National Monument (PMNM); the marine environment around Johnston Atoll in the Pacific Remote Islands Marine National Monument (PRIMNM); the marine environment around Ni‘ihau, Oahu and the big island of Hawai‘i; the Geologists





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Seamounts located about 100 miles south of Honolulu; and the vessel transit areas between Honolulu, Hawai'i and these locations where ESA-listed marine species or their habitats may be impacted by the proposed activities.

Within the PMNM, focused operations are planned from Middle Bank on the southern border of the Monument northwest reaching up to Pearl and Hermes Atoll. Within the Johnston Atoll portion of PRIMNM, focused operations are planned at Horizon tablemount, through both the Karin and Johnston Seamount chains, and offshore of Johnston Atoll. Operations offshore of Oahu are planned on the south and southeast side of the island, and on the west/southwest side of the Hawai'i.

**Species That May Be Affected:** OER has determined that the proposed action may affect but is not likely to adversely affect green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), North Pacific distinct population segment of loggerhead sea turtles (*Caretta caretta*), olive ridley sea turtles (*Lepidochelys olivacea*), leatherback sea turtles (*Dermodochelys coriacea*), Main Hawaiian Islands false killer whale distinct population segment (*Pseudorca crassidens*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), fin whales (*Balaenoptera physalus*), blue whales (*Balaenoptera musculus*), sei whales (*Balaenoptera borealis*), North Pacific right whales (*Eubalaena japonica*), the Indo-West Pacific distinct population segment of the scalloped hammerhead shark (*Sphyrna lewini*), Hawaiian monk seals (*Neomonachus schauinslandi*), and Hawaiian monk seal critical habitat. Detailed information about the biology, habitat, and conservation status of sea turtles can be found in their recovery plans and other sources at <http://www.nmfs.noaa.gov/species/turtles/>. The same can be found for Hawaiian monk seals and cetaceans at <http://www.nmfs.noaa.gov/species/mammals/>; and for scalloped hammerhead sharks at [http://www.fwr.noaa.gov/PRA/and\\_scalloped\\_hammerhead\\_shark.html](http://www.fwr.noaa.gov/PRA/and_scalloped_hammerhead_shark.html).

**Critical Habitat:** The proposed action would take place within designated monk seal critical habitat. Critical habitat was designated under the ESA for the Hawaiian monk seal on April 30, 1986 and revised on May 26, 1988. Designated critical habitat includes all beach areas, lagoon waters, and ocean waters out to a depth of 20 fathoms around Kure Atoll; Midway Islands (except Sand Island), Pearl and Hermes Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Necker Island, Maro Reef, and Nihoa Island. On June 2, 2011, NMFS proposed revising critical habitat for monk seals by extending the current designation out to the 500 meter depth contour and including Sand Island at Midway Island but this proposal is not yet final.

**Analysis of Effects:** In order to determine that a proposed action is not likely to adversely affect listed species, NMFS must find that the effects of the proposed action are expected to be insignificant, discountable, or beneficial as defined in the joint USFWS-NMFS Endangered Species Consultation Handbook: (1) insignificant effects relate to the size of the impact and should never reach the scale where take occurs; (2) discountable effects are those that are extremely unlikely to occur; and (3) beneficial effects are positive effects without any adverse effects (USFWS & NMFS 1998). This standard, as well as consideration of the probable duration, frequency, and severity of potential interactions, was applied during the analysis of effects of the proposed action on ESA-listed marine species, as is described in detail in the OER



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consultation request. The OER determined that the risk of collisions with vessels and the risk of entanglement would be discountable; and that the risk from exposure to elevated noise level, disturbance from human activity, as well as exposure to wastes and discharges would result in insignificant effects on ESA-listed sea turtles, marine mammals and the scalloped hammerhead shark, and that the potential effects of the proposed action to designated or proposed critical habitat would also be insignificant.

Considering the information and assessments presented in the OER consultation request, and in the best scientific information available about the biology and expected behaviors of the ESA-listed marine species considered in this consultation; NMFS agrees that: 1) the list of ESA-listed species and critical habitats potentially exposed to the effects of the action is correct, 2) the suite of identified stressors is comprehensive, and 3) the assessment of exposure risk and significance of exposure to those stressors is accurate. Therefore, NMFS agrees that the risk of collisions with vessels and the risk of entanglement would be discountable for marine mammals, sea turtles and the scalloped hammerhead shark; and that those animals would be unlikely to respond to elevated noise level, disturbance from human activity, as well as exposure to wastes and discharges, and if perchance a response were to occur, it would be temporary in nature and never reach the scale where it would affect the individual's health, and as such, cause insignificant effects; and that the action would have insignificant effects on critical habitat.

Conclusion: NMFS concurs with your determination that the proposed cruises of the Okeanos Explorer are not likely to adversely affect ESA-listed marine species, and would have insignificant effects on designated or proposed critical habitat. This concludes your consultation responsibilities under the ESA for species under NMFS's jurisdiction. However, this consultation focused solely on compliance with the ESA. Additional compliance review that may be required of NMFS for this action (such as assessing impacts on Essential Fish Habitat) would be completed by NMFS Habitat Conservation Division in separate communication, if applicable.

ESA Consultation must be reinitiated if: 1) a take occurs; 2) new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; 3) the identified action is subsequently modified in a manner causing effects to listed species or designated critical habitat not previously considered; or 4) a new species is listed or critical habitat designated that may be affected by the identified action.

If you have further questions please contact Richard Hall on my staff at (808) 725-5018. Thank you for working with NMFS to protect our nation's living marine resources.

Sincerely,

Michael D. Tosatto  
Regional Administrator



# Ocean Exploration and Research

## Appendix H: Acronyms

.hex—Hexadecimal  
3D—Three-dimensional  
AERONET—Aerosol Robotic Network  
AMA—Reddit’s Ask Me Anything  
ASCII—American Standard Code for Information Interchange  
BIST—Built-in self-test  
BM—Bernice Pauahi Bishop Museum  
CAPSTONE—NOAA’s Campaign to Address Pacific monument Science, Technology, and Ocean NEeds  
CARIS—Teledyne Computer Aided Resource Information System  
CIT—Chiba Institute of Technology  
CO—Commanding Officer  
CSV—Comma-separated values  
CTD—Conductivity, temperature, and depth  
*D2—ROV Deep Discoverer*  
DGIT—Design Guide Implementation Team  
DMNH—Delaware Museum of Natural History  
DNA—Deoxyribonucleic acid  
DO—Dissolved oxygen  
ECC—Exploration Command Center  
EEZ—Exclusive economic zone  
ESA—Endangered Species Act  
ET—Electronics Technician  
*EX—NOAA Ship Okeanos Explorer*  
FeMn—Ferromanganese  
FFS—French Frigate Shoals  
FLMNH—Florida Museum of Natural History  
FSU—Florida State University  
FTP—File transfer protocol  
HBOI—Harbor Branch Oceanographic Institute  
HD—High-definition  
HURL—Hawai’i Undersea Research Laboratory  
IUCN— International Union for Conservation of Nature  
IRC—NOAA’s Inouye Regional Center  
JAU—Johnston Atoll Unit  
Kbps—Kilobit-per-second  
KMZ—Keyhole Markup language Zipped  
LED—Light-emitting diode  
LSU—Louisiana State University  
 $M_2$ —Principal lunar semi-diurnal tidal constituent  
MAN—NASA’s Maritime Aerosol Network  
MB—Megabyte



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MBARI—Monterey Bay Aquarium Research Institute  
MBES data—Multibeam Echo Sounder System data  
Mbps—megabit-per-second  
MGR—Marine Geology Repository  
MPA—Marine protected area  
MS—Microsoft  
MTN—Maritime Telecommunications Network, satellite service provider  
NAO—NOAA Administrative Order  
NASA—National Aeronautics and Space Administration  
NCDDC—NOAA National Coastal Data Development Center  
NCEI—National Centers for Environmental Information  
NEPA—National Environmental Policy Act  
NEU—Northeastern University  
NGDC—NOAA’s National Geophysical Data Center  
NMFS—NOAA’s National Marine Fisheries Service  
NOAA—National Oceanic and Atmospheric Administration  
NWHI—Northwest Hawaiian Islands  
O<sub>2</sub>—Oxygen  
OER—NOAA’s Office of Ocean Exploration and Research  
OGL—Ocean Genome Legacy  
OMAO—NOAA’s Office of Marine and Aviation Operations  
OSU—Oregon State University  
PCZ—Prime Crust Zone  
PERC—Planetary Exploration Research Center  
PI—Principal Investigator  
PIFSC—Pacific Islands Fisheries Science Center  
PMNM—Papahānaumokuākea Marine National Monument  
POC—Point of contact  
PPSIO— P.P Shirshov Institute of Oceanology  
PRD—Protected Resources Division  
PRIMNM—Pacific Remote Islands Marine National Monument  
QA/QC—Quality assurance/quality control  
RAID—Redundant array of independent disks  
ROV—Remotely operated vehicle  
SBP—Subbottom profiling  
SCS— Scientific Computer System  
SD—Scientific Data  
SIS—Seafloor Information Software  
SODA—Sampling Access Database Application  
SSH—Secure Shell  
SVP—Sound velocity probe  
TAMU—Texas A&M University  
TAMU-CC—Texas A&M University-Corpus Christi  
TB—Terabytes



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TRU- transmit/receive unit  
TSG—Thermosalinograph  
UCAR—University Corporation for Atmospheric Research  
UH—University of Hawai'i  
ULL—University of Louisiana at Lafayette  
USBL—Ultra-short baseline  
USGS—U.S. Geological Survey  
USNM—National Museum of Natural History, Smithsonian Institution  
UTC—Universal Time Coordinated  
VNC—Virtual Network Computing  
VoIP—Voice over Internet Protocol  
VSAT—Very Small Aperture Terminal  
WHOI—Woods Hole Oceanographic Institute  
WSG84 datum—World Geodetic System 1984  
XBT—Expendable bathythermograph